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ENVIRONMENT VIEWS

2
VOLUME SIX
NUMBER ONE
JANUARY/FEBRUARY 1983

SECOND CLASS MAIL REGISTRATION NUMBER 4405

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Weather and Climate

ISSN 0701-9637

ENVIRONMENT VIEWS

Contents

The Art and Science of Weather 3

Weather and Climate: What Are they? 5
Unravelling the mysteries.

The History of Meteorology and Climatology 10
Did Aristotle start it all?

Forecasting 13
Getting better all the time.

Measuring Climate and Weather 17
What is measured, why and with what?

Comment 22

Weatherlore 24
Of watching squirrels, trees and the sky.

Change and Variability 28
A cold winter doesn't necessarily mean the return of the glaciers.

Severe Weather 31
Predicting and coping with tornadoes, storms and hail.

Environment Update 36

Environment Views is published bi-monthly by Alberta Environment. Each issue deals with a specific topic from various viewpoints with the aim of increasing awareness of environmental issues among Albertans. *Environment Views* is directed by an independent board with representation from environmental groups, government and industry. The views expressed by the publication are not necessarily those of Alberta Environment.

Subscriptions are free and can be obtained by mailing the enclosed card. When notifying *Environment Views* of a change of address, please quote the subscription number on your mailing label.

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Cover photo: *Susanne Swibold*

Alberta
ENVIRONMENT

Introduction: Maryhelen Vicars

The Art and Science of Weather

The weather business is not for the thin-skinned. On an unexpectedly miserable weekend, the weather office's popularity can be about as low as the post office's, and for about the same reason — you just can't seem to count on them.

In helping select photographs of instruments to illustrate this issue of Environment Views — the first of two on climate and weather — meteorologist Bruce Thompson was a bit diffident about a book on sunshine recorders. The reason? This particular instrument uses a large crystal ball, to focus the sun's rays onto a recording paper. Weathermen are not amused by references to crystal balls.

If we do nothing else with this issue, we hope to inspire a bit more compassion for the much-maligned weatherman, as we attempt to show just what the forecaster is up against.

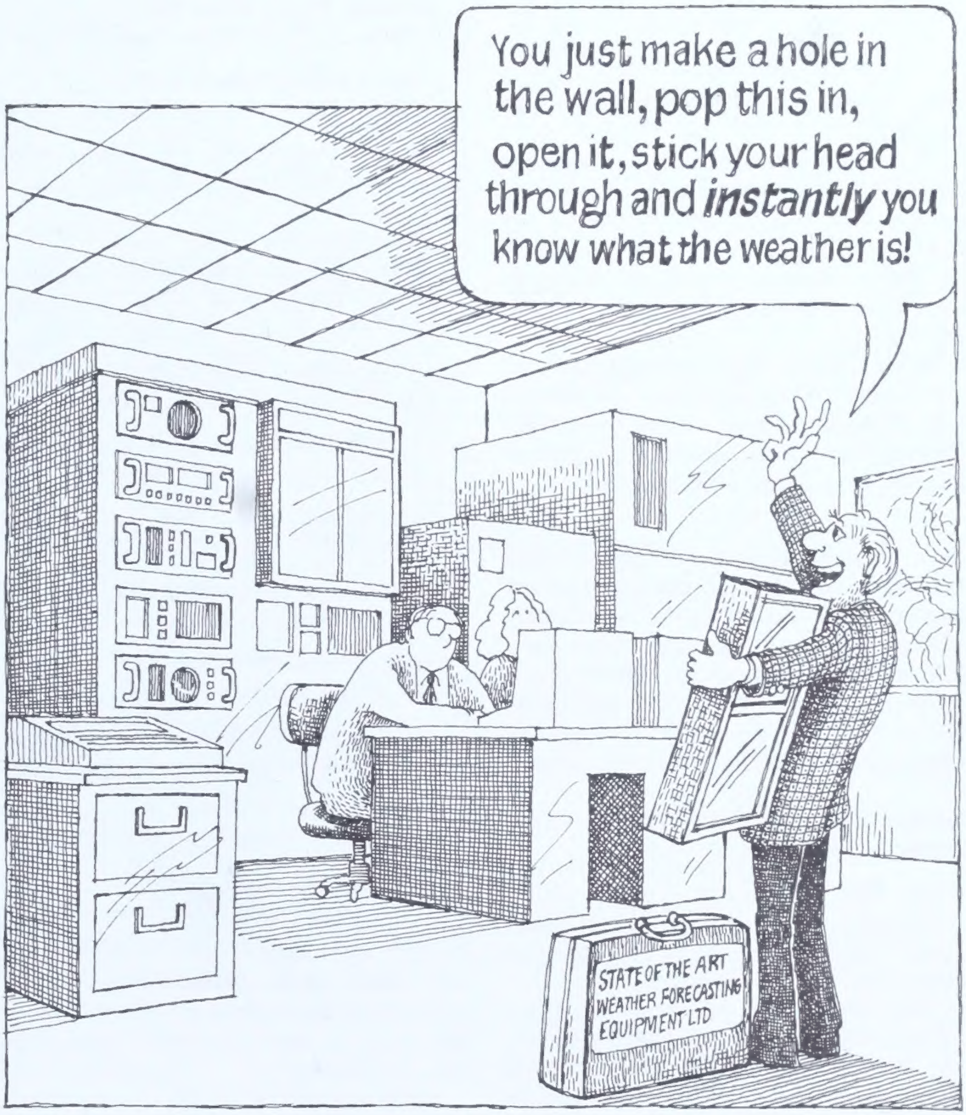
The art and science of prediction and forecasting have come a long way since the sixteenth and seventeenth centuries when the thermometer and barometer were invented, and even farther since the aviation revolution of the second world war greatly increased the demand for precise weather information.

The thermometer and barometer have been joined by a vast arsenal of space-age equipment to measure, record and transmit weather information from thousands of points on the earth and from far into space.

Handled by highly trained specialists with the latest in computer technology at their command, this data makes the Canadian weather forecaster correct 80 to 85 per cent of the time.

And although you may feel let down if it is your picnic that gets ruined as a result of the other 15 to 20 per cent, those are really pretty good odds.

At the other end of the scientific spectrum, there are still many who turn their backs on the satellite photos and the computer-drafted weather maps in favor of the reading of natural signs, an art which has not entirely been eclipsed by the rapid meteorological developments of the past decade or two.


You just make a hole in the wall, pop this in, open it, stick your head through and *instantly* you know what the weather is!
STATE OF THE ART WEATHER FORECASTING EQUIPMENT LTD

For hikers, hunters and farmers, being prepared for the day's weather can mean the difference between success and failure, or disaster. Such people learn to watch the sky, animals and even plants for more precise guidance than the radio may be able to offer for their particular corner of the world.

Similarly, there is a long tradition of weather wisdom among North American Indian cultures. Living on the land, Indians needed a working knowledge of the weather, not only their own comfort but to help predict the movements of the game on which they depended. While most natives are farther removed from a direct dependence on the land now, a deep respect for those wise in weather lore is part of their cultural heritage.

Interpreting climate and weather in the space of seven stories, as we have in this issue, is a little like putting a dozen people in a Volkswagen — there are bound to be parts left out.

But we hope what our writers learned and were able to pass along about the related fields of meteorology and climatology will help make the six o'clock weather broadcast a little more meaningful. Also, the information will serve as backgound for our next

How cold was it, really?

There are more than 100 degrees Celsius separating the lowest recorded temperature in Canada from the highest: from a record low in the Yukon of -63 to a record high in Saskatchewan of 45. The huge range in weather conditions applies to snow and rain, too, as the country includes three coastlines, a vast plains, mountain regions, rain forests and lake districts. Except perhaps in January, when it seems that every part of the country except Victoria is in the deep freeze, there is no Canadian climate.

Some examples of this variability:

Canadian Records

Highest Official Temperature:	
Midale and Yellowgrass, Saskatchewan July 5, 1937	45°
Lowest Official Temperature:	
Snag A, Yukon Territory February 3, 1947	-63°
Greatest Precipitation For One Climatological Day:	
Ucluelet, B.C. October 6, 1967	489 mm

Alberta Records

Highest Official Temperature:	
Bassano Dam July 21, 1931	43.3°
Fort MacLeod July 18, 1941	43.3°
Lowest Official Temperature:	
Fort Vermilion January 11, 1911	-61.1°
Greatest Precipitation for One Climatological Day:	
Eckville South June 30, 1970	213.1 mm
Greatest Precipitation For One Month:	
Adams Creek lookout June 1980	403.7 mm
Greatest Annual Precipitation:	
Waterton Park Headquarters 1965	1364.1 mm
Least Annual Precipitation:	
Fort MacLeod 1943	123.8 mm
Greatest Snowfall in One Climatological Day:	
Livingston Ranger Station June 29, 1963	111.8 cm
Greatest Monthly Snowfall:	
Columbia Icefields January 1974	286.5 cm
Greatest Seasonal Snowfall:	
Columbia Icefields 1973-74	1065.9 cm

issue, on the human side of climate and weather.

We will look into the impact of weather and climate on man: on such industries as construction, forestry and agriculture; on health, both physical and psychological; and on culture. And, to balance the equation, we will look at man's impact on weather and climate.

What happens when vast tracts of forest are cleared? When huge lakes are formed behind dams? And on a larger scale, what effect will air pollution, particularly carbon dioxide, have on the atmosphere?

* * *

After the publication of our issue on public land use (September/October) we received two letters from concerned four-wheel-drive club people. Bev Wadsworth, whose letter follows, was photographed at the wheel of a four-wheel-drive vehicle in an illustration for a story which dealt with the impact of increased public access to the back country.

October 1982 issue of Environment Views.

Letter to the Editor:

Dear editor,

In response to your article "Using Public Land," I am appalled with your misleading statements and photographs.

You seem eager to insinuate that all four wheelers have the common goal of trespassing, destroying land, and driving wildlife from their homes. The two photos of four wheelers you have used in your article, presumably to prove your point, are of myself and a colleague, both members of the Alberta Four Wheel Drive Association.

For your information, the land you see in these pictures is private land, *not public land as you have indicated. Permission was granted by the owner of this land, for our use, as well.*

Secondly, you would not have found any animals on that particular piece of land on that particular day because people who care ensured this for all around safely. And thirdly, our Association and everyone who is a member knows and understands how land and wildlife can be affected through abuse, as anything can, and take special efforts and much care to leave the environment as it was, and should be.

Since it is obvious at least your photographer attended our rally to take pictures, it seems apparent he didn't see or learn much about four-wheeling, as the vehicles pictured in your article are not carrying *their drivers "into the bush, to areas critical to wildlife," but rather we are participating in a well organized 4X4 rally, which include specific rules pertaining to the care of the environment.*

Your innuendoes of environmental abuse in my opinion are in poor taste and show a definite lack of research and "fair play."

I will close this letter now, with the sincere hope that you will educate yourself and your readers on this matter, and that this and other letters will provoke an apology to all members of The Alberta Four Wheel Drive Association, as damaging articles like this affect us all.

Sincerely,
Bev Wadsworth

We regret if the wording of the caption of the photograph seemed to imply that the photographs were taken in the back country. That was not our intention, nor did we mean to malign all "four-wheelers." In fact, as the writer, points out, the photos were taken at a rally. We do think, however, that the caption: "Four-wheel-drive vehicles can carry their drivers far into the bush, to areas critical to wildlife" is factual, and borne out by our discussion of access problems in this story and in one other in the public land use issue.

Alberta. Dept of the Environment
Ah.1.478
CV

ALBERTA ENVIRONMENT

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September, 1981

Department magazine dealing with environmental issues in Alberta. A subscription is available free of charge on request.

Note: Environment Views was preceded by a publication entitled Environment News. Back issues of Environment News deal with:

--Conserver Society
--Urban Environment

Available in class sets with teachers' guide. (high school)

Back issues include:

Recycling -- Volume 1, No. 1, April-May, 1978 -- Deals with the recycling of materials in Alberta including paper, metal, glass and oil. It also looks at attempts to increase recycling. (CURRENTLY OUT OF PRINT) Student's guide is available.

Alberta's Lakes -- Volume 1, No. 2, June-July, 1978 -- This edition focuses on lake shoreland problems including conflicts over uses such as recreation, wildlife habitat, etc. The nature of Alberta shorelands is also discussed. (CURRENTLY OUT OF PRINT) Student's guide is available.

Endangered Environments -- Volume 1, No. 3, August-September, 1978 -- Covers threatened environments ranging from sand dunes, to prairie grasses, urban areas and historic sites. Student's guide is available.

Agriculture and the Environment -- Volume 1, No. 4, October-November, 1978 -- This issue discusses topics such as agricultural trends and environmental quality, agriculture and pollution and reconciling the needs of wildlife and farmers. (CURRENTLY OUT OF PRINT) Student's guide available.

Automobiles and the Environment -- Volume 1, No. 5, December-January, 1978-79 -- Deals with the environmental price of society's reliance on the automobile and examines alternatives to the "One-Person, One-Car" syndrome. Student's guide available.

Public Participation in Environmental Management -- Volume 1, No. 6, February-March, 1979 -- Discusses the growing involvement of citizens in the environmental decision-making process, including specific examples of environmental groups and individuals, and a debate on whether or not citizen involvement is detrimental to the environment.

Energy and the Environment: I -- Volume 2, No. 1, April-May, 1979 -- Deals with the impact of energy production on the environment.

Energy and the Environment: II -- Volume 2, No. 2, June-July, 1979 -- Deals with the environmental impacts of energy distribution and consumption.

River Shorelands -- Volume 2, No. 3, August-September, 1979 -- This issue examines the resource of river shorelands in Alberta, including articles on the types of river shorelands in the province; their historical aspects; their use by wildlife, municipalities, industries and homeowners; floodplain zoning, and the aesthetics of construction along shorelands.

Pesticides and the Environment -- Volume 2, No. 4, October-November, 1979 -- Discusses pesticides, their future, benefits, alternatives, man and wildlife, uses for households, agriculture and industry. Teacher/student guide available.

Environmental Education -- Volume 2, No. 5, December-January 1979/80 -- This issues examines different views and approaches to environmental education, the role of parks, residential centres, and other resources, and tips for teachers. Teacher/student guide available.

Hazardous Wastes -- Volume 2, No. 6, February-March 1980 -- Discusses the controversial topic of hazardous waste disposal, including a guide to some of Alberta's hazardous wastes, different approaches to hazardous waste disposal, the need for controlled waste disposal, health hazards of uncontrolled disposal, and the individual's responsbility in disposing of hazardous wastes. Student's guide available.

Sewage Disposal -- Volume 3, No. 1, April-May, 1980 -- Discusses methods of sewage disposal in Alberta; alternatives to river discharge; options for sludge disposal; planning for sewage disposal in growth areas; individual disposal systems; and the consumer's role in efficient disposal. Student guide available.

Water Resources Management: 1 -- Volume 3, No. 2, June-July, 1980 -- Considers some of the general principles and problems of water resources management in Alberta, which have inter-provincial and international consequences. Student guide available.

Water Resources Management: 2 -- Volume 3, No. 2, June-July, 1980 -- Continues the discussion of water resources management started in part 1, with a special focus on irrigation, the province's main consumer of water. Student guide available.

Growth and Development -- Volume 3, No. 4, October-November, 1980 -- The social-economic effects of growth and development in Alberta are examined along with government policies, direct growth and how it has been handled across the continent. Student/Teacher guide available.

Population and Environment -- Volume 3, No. 5, December-January, 1980-81 -- Population growth is discussed from a variety of perspectives: global, national and provincial. The history and effect of rapid population growth in Alberta are also examined along with general society views about birth control and abortion. Student/Teacher guide available.

Soils and the Environment -- Volume 3, No. 6, February-March, 1981 -- Soils and the major concerns of soil use in agriculture and forestry are examined. Special emphasis on Alberta's changing pattern of soil use, soil research and management. Student/Teacher guide available.

Land Reclamation -- Volume 3, No. 7, April-May, 1981 -- The role of government, industry and the public in reclaiming land disturbed by energy exploration, mining, highway construction and water resource projects and other development is examined. Student/Teacher guide is available.

Groundwater -- Volume 4, No. 2, June-July, 1981 -- This issue focusses primarily on the groundwater resource in Alberta, tracing its history, quality and availablity in the province. Groundwater use, development, management and research in other parts of the world are also discussed. Student/Teacher guide available.

Noise Pollution -- Volume 4, No. 3, August-September, 1981. This issue reviews nature and extent of noise pollution in Alberta and reviews some of the possible solutions. Student/Teacher guide is available.

Regional Review -- Volume 4, No. 4, October-November, 1981 -- A look at the province's environmental concerns by regions as perceived by government, industry, environmental groups and the man in the street. Studen/Teacher guide available.

Note: An upcoming issue of Environment Views will focus on the Human Side of Energy (December-January).

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by Norma Ramage

Weather and Climate: What are they?

Alberta has a temperate climate, but
its January weather is anything but temperate.

There's no doubt about it. Weather and climate are important factors in our lives.

So important that they influence many things: Whether we take that winter trip in the car; the clothes we wear; the spot we choose for a vacation. Weather and climate have become so vital that we shoot satellites into space and maintain boats on the oceans to monitor and predict weather and climatic changes. They're so important that the CIA and KGB operate special task forces whose sole task is to predict weather changes.

Yet despite this, most people know little about them except where to find the local forecast in their daily newspaper.

One of the first problems the layman has is in differentiating between climate and weather. The words are often used interchangeably. Actually, weather is the rain, sun, heat, cold or winds which happen now while climate is the long-term average which describes what generally happens. Alberta, for example, can be said to have a reasonably temperate climate, but on a given January day, the actual weather may be anything but temperate.

Despite this difference in definition, climatologists and meteorologists will explain that climate and weather are inextricably entwined. To try to treat them as totally unrelated entitities is to get involved in a chicken and egg argument, says climatologist Dr. Lawrence Nkemdirim of the University of Calgary. However, Nkemdirim does pinpoint four factors as the major determinants of climate: position on the globe, wind systems, the ratio of water to land, and topography.

"By far the biggest impact on climate is latitude, where you are on the globe," he explains.

"Both the sun's radiation and the wind circulation patterns are latitudinally based."

The sun's influence on climate is the most basic and the easiest to understand. Because of the shape of the spherical earth, the sun's rays are more concentrated at the equator than they are at the poles. The result is obvious: it's warmer in Brazil than it is in Greenland.

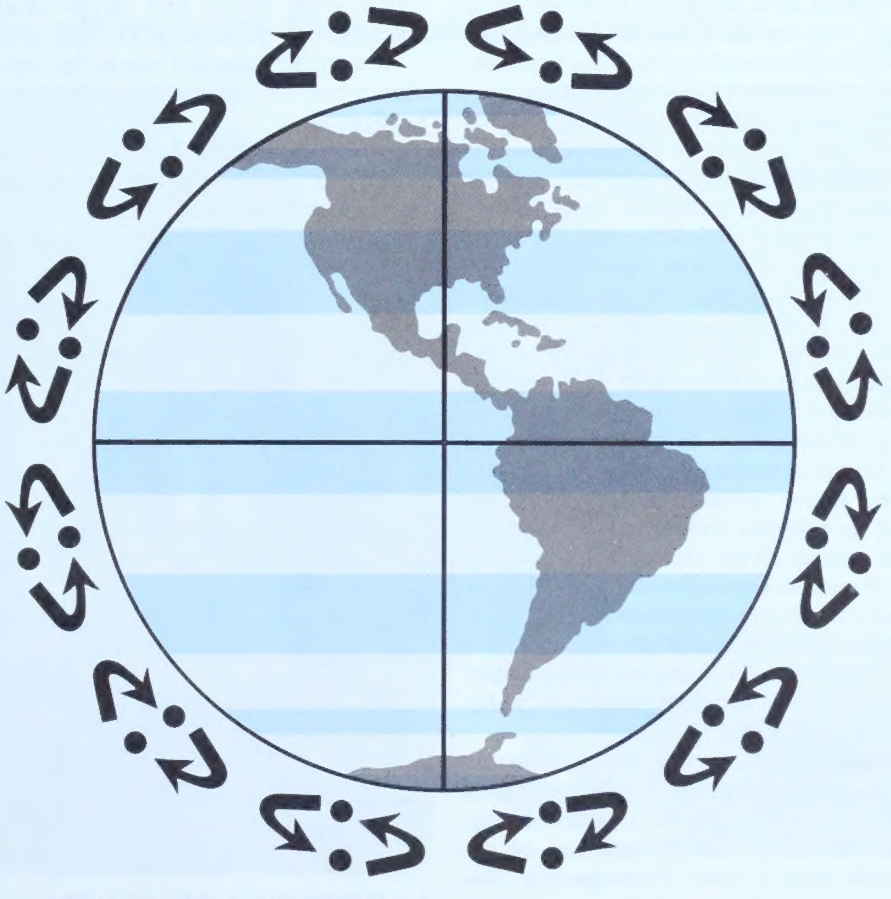
However, position on the globe can't explain everything. If latitude was all that counted, cities and countries at the same latitude would have identical climates, but they don't. Other factors come into play, the most important of which is wind circulation.

Heat is airlifted and passed from the equator to the poles, displacing existing air and creating a gigantic global bucket brigade of pressure cells transferring heat away from the equator. (see illustration) If these pressure cells were the only factors affecting wind, all winds on earth would blow from north to south and each day's weather would remain the same.

However, because the earth spins on its axis, a new factor, the Coreolis force, comes into play. This spin effect has long been recognized in the old wives' tale that water runs down the bathtub drain counter clockwise in the northern hemisphere and clockwise in the south.

The tale has its basis in the Coriolis effect on wind. The earth spins faster at the poles than at the middle latitudes. In the northern

Global Bucket Brigade



Adapted From Time-Life Science Series

Susan Brun

and middle latitudes, the Coriolis is strong enough to force the winds to deflect at an angle, creating the Westerlies in the northern hemisphere and the matching Easterlies south of the equator. (see illustration)

"But at the lower latitudes, the air flows more in a north-south direction because the Coriolis effect is not as strong," explains Nkemdirim. The result is the Trade Winds, the second of the world's great circulation systems. The third is the Polar Easterlies.

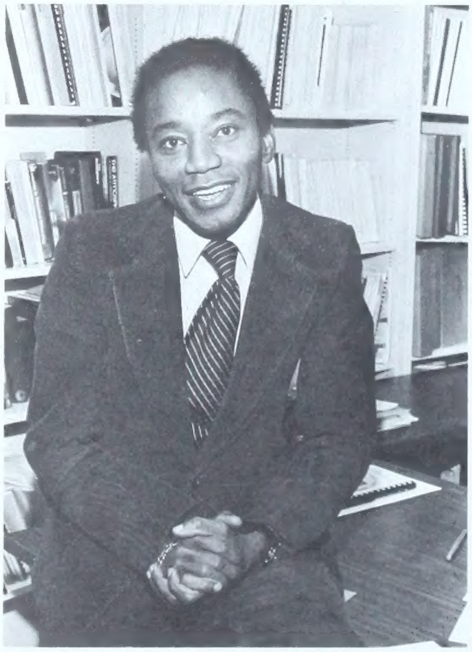
But what specific affect do these winds have on climate? Canada, like most of North America, lies under the influence of the Westerlies. It is this prevailing current that makes the climate of Canada's west coast very different from that of the east. The Westerlies blow sea air onshore — mild air in the winter and cool air in the summer —to give British Columbia its moderate, mild climate. In the Maritimes, the prevailing Westerlies blow offshore, giving the east coast a more extreme climate and one more similar to that of inland Canada.

These winds also interact with another major factor in determining climate: water and its relationship to land.

Ralph Langemann, a meteorologist at Calgary's Mount Royal College, explains that water is more stable in terms of temperature changes and in its affect on air masses than is land. Consequently, the northern hemisphere with its larger percentage of land has a more extreme climate as well as more violent and abrupt weather changes.

One of the reasons Calgary has the climate it has, says Nkemdirim, is because it's landlocked.

"We're trapped into suffering all our heat in summer, for example, without the moderating influence of a sea breeze."



Bill McKeown

LAWRENCE NKEMDIRIM

Perhaps the most dramatic example of the influence of water on climate is the contrast between the Faroe Islands in the North Atlantic (hottest month plus 11 Celsius, coldest month plus 3.7 Celsius) and Yakutsk in eastern Siberia (July plus 19.5 and January minus 43) both of which lie at latitude 62 degrees North.

Oceans also act as huge storage areas for heat, releasing their trapped energy in fall and winter to bring milder climates to islands and coastal areas.

The oceans also transmit heat and cold around the world in the form of great ocean currents such as the Gulf Stream. These currents give areas a higher or lower temperature than they would otherwise have, says Nkemdirim.

"For example, Iceland has a more moderate climate than its latitude would lead you to expect because of warm currents while Labrador is much cooler than its latitude deserves because of the cold ocean currents that run by it."

The fourth major factor influencing climate is topography. Land masses can influence climate in numerous ways. Mountain ranges can force air masses to rise and drop their moisture, creating extremely wet conditions on one side of a mountain range and a drier climate on the other. Various topographical features can create specific types of climate influencing winds.

A chinook arch extending over the Calgary Skyline.

The topographical feature most familiar to Albertans and the one that has a major influence on climate in western Canada, is the Rocky Mountains.

"If you want to change the climate of the Prairies, just get a million men with pickaxes and level the mountains," says Nkemdirim.

For one thing, the mountains cause the famous chinook winds of southern Alberta. The chinook is a trans-mountain wind that loses its moisture as it sweeps up the mountain barrier, blowing warm and dry on the other side. The Rockies also drain air masses of their moisture, making the climate on the east side of the range relatively dry. Living proof is readily available to any hiker who crosses the Great Divide. On the west, the vegetation suddenly becomes much lusher and more verdant than that he has passed through on the eastern slopes.

These factors all play a vital role in weather as well as climate. For example, the chinook, while an enduring factor of climate, also has a major impact on the day to day weather of southern Alberta. But, says Langemann, the immediacy of weather is caused by another factor, the characteristics and movement of great masses of air. These air masses, he says, are simply blobs of air with similar characteristics.

"For example, an Arctic air mass starts out in the Arctic and simply picks up the temperature and moisture content of that area and then brings these conditions down to us."

There are several air masses that create North American weather (see diagram) and since they are not all seasonal, as they tend to be in the southern hemisphere, weather here can be much more changeable and turbulent than in other areas of the world.

Each of these air masses, as it moves into an area, brings changes in temperature, humidity and wind. An Arctic air mass, for example, will bring cool, crisp air, clear skies and brisk winds. As long as an air mass stays in an area, the weather will remain unchanged. But these air masses move and collide and with this movement comes a change in weather.

When air masses meet on a "front," says Langemann, "then you get weather." One of the problems laymen have in understanding weather is the dual meaning of the word front, the meteorologist explains. In one case, front is used to refer to the boundary line between two unlike air masses. But it is also applied to an outthrust of air from one air mass into another. For example, when a cooler air mass meets a warmer one, a tongue or front of cold air may be thrust into the warm air mass creating a "cold front."

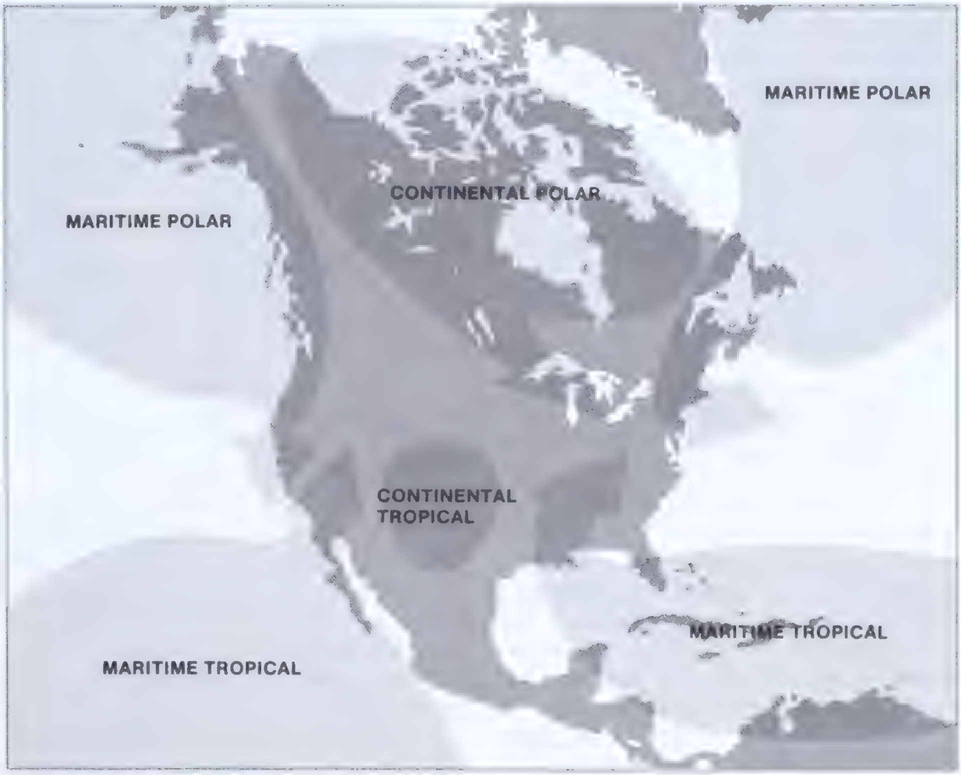
The term front was originally adapted from the military because, similar to a battle, the conflict between the air masses is fought out on a narrow, restricted field.

"What people don't realize is that these air masses may be thousands of miles across and the weather can be stable everywhere except where they meet," says Langemann.

So if a front is over Moose Jaw on Tuesday, that city will experience rapid weather changes. If the front gradually moves westward, Moose Jaw's weather may stabilize and Calgary could experience a sudden, dramatic weather change.

Why do these air masses move? Langemann says many reasons have been postulated but no one is completely sure. From the viewpoint of the layman, it is enough to know that they do move and when they meet, weather changes. For example, when a cold front moves into the area of a warm

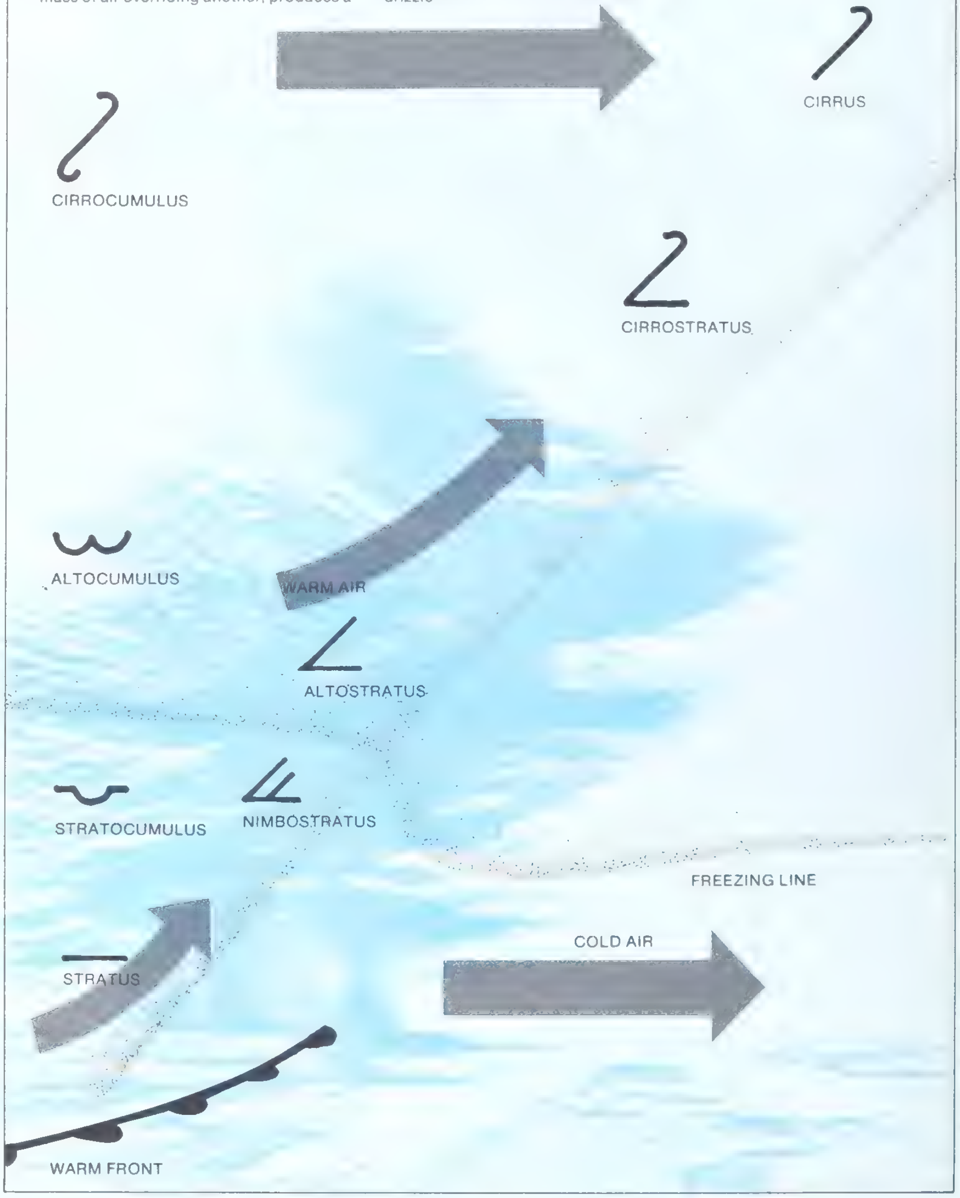
The air masses that create our weather



At various times, these six air masses influence northern hemisphere weather.

A HEATED INVASION

This diagram shows what happens when warm air attempts to invade an area where cold holds sway. The warm air rides over the cold, planing forward, sometimes for 1,000 miles. The band of conflict, with one mass of air overriding another, produces a sequence of weather which ends in rain. First icy cirrus and cirrostratus clouds form (top). These thicken into alto-stratus - and the warm front rainstorm has arrived. Trailing along behind is low altitude stratus, capable only of manufacturing drizzle



Adapted From Time Life Science Series

air mass it generally forces the warm air aloft because the warm air is lighter. As the air rises it relases its moisture in the form of precipitation (see diagram). When a warm front tries to move into the area of cold air, it may be deflected aloft, causing similar results.

When a meeting of air masses causes clouds, the atmosphere warms up, making the air unstable and causing precipitation. It is important to understand that the atmosphere is not heated from above by the sun's rays but from below by radiated heat from the earth. Some of the sun's rays carom off the atmosphere while others hit the earth and are absorbed and still others are reflected back up into the air. If clouds block these rays, the air becomes heated and unstable and the result is dramatic weather change, such as summer thunderstorms.

It is this radiant heating of the atmosphere that lies at the root of one of the most critical climatic problems we face today — the so-called greenhouse effect. It works this way: In earlier times, the carbon dioxide produced by man was broken down and used by plants and trees. However, with our increase in the production of carbon dioxide, primarily through the use of fossil fuels such as oil, coal and gas, we are producing more carbon dioxide than the plants can handle. About six billion tonnes of carbon dioxide now goes into the atmosphere every year.

This gas has a worrisome property. It traps heat and blocks certain wavelengths of light which would normally be reflected back into space. As a result, more heat is trapped by the earth in much the same way glass traps heat in a greenhouse.

Experts are divided about the possible result of this greenhouse effect, although current best predictions suggest the warming will become measurable by the end of this century and by 2050 the globe's average temperature could be two degrees higher.

But Nkemdirim says no one is really sure what the effect will be.

"There could also be a potential increase in moisture in the atmosphere because warm air rises and releases moisture, basically the way a humidifier works. This would create more clouds and block some of the sun's rays coming in so our climate could become wetter and cooler. So the two could cancel each other out or maybe our temperature will drop a degree or two."

One or two degrees either way doesn't sound crucial but the effects could be literally earth-destroying.

An increase of one or two degrees could make vast areas of the world uninhabitable. Areas like the northern Mekong Delta and northern India where temperatures currently reach 45 degrees with high humidity would become unbearable. The 86 million people who live on the margins of deserts in Israel, Iran and Iraq could watch their soil disappear as hotter temperatures rob it of moisture. In an area of the world where tensions are always ready to explode, temperature changes could lead to bitter warfare.

Canada, on the other hand, might benefit from an increase in temperature as more areas become available for growing crops.

A *decrease* of one or two degrees, however, could have a devastating affect on the grain growing areas of the prairies, says Langemann.

"Right now, we already know that if our average temperature drops even one degree, half the grains we now grow couldn't survive. The growing season would be shortened by a week or two and the frost would kill the crops."

And, says Langemann, one or two-degree changes aren't something that take hundreds of years to come about. It could take as little

Cirrus

Altocumulus

Cumulus

Thunderstorm

time as 50 years.

Why, then, with these horrifying visions before us, is nobody doing anything about it?

The problem, says Nkemdirim, is that people take climate and weather too much for granted.

"Weather is like water. It's there all the time and we only miss it when it's gone. We only notice climate and weather when they change."

Where our grandfathers in sod shacks had to understand the effects of weather just to survive, in today's society we are cushioned from it in heated houses and air conditioned cars.

"I think the attitude of most people is that the weather is something the government should do something about. It's not their concern," says Nkemdirim.

Business, too, has been slow in coming to grips with the way climate can effect them and the result has often been totalled in millions of dollars.

In 1970, for example, it cost Hydro Quebec $30 million to replace a section of the Quebec-Labrador power line which toppled during a storm because it wasn't strong enough to withstand previously recorded ice and wind loadings.

And every western Canadian is familiar with stories about door handles on British or American built cars that freeze in odd positions during the extremes of a Canadian winter. Or of ski hills that went bankrupt because their developers didn't study snowfall records.

But despite this seeming indifference to weather, world-renowned climatologist Kenneth Hare of the University of Toronto's Trinity College calls climatology "the study of the 70s." Nkemdirim agrees.

"A lot of things happened in the seventies to make that true. There were unexpected droughts, glacial surges, changes in the Greenland ice cap and we were finally able to quantify a clear indication of a global cooling trend. It was as if everything was out of sync and it made a lot of people aware of the importance of studying and predicting climate."

Norma Ramage is a Calgary journalism instructor and freelance writer

Myron Johnson

The History of Meteorology and Climatology

Of Aristotle, Galileo and the geostationary satellite.

Weather has such an impact on man's daily life that it is not surprising attempts to understand and explain atmospheric conditions have been made for centuries.

The history of meteorology and climatology can be traced back to before the birth of Christ, yet it is only in recent decades that weather forecasting has developed into a sophisticated science.

The earliest studies of meteorology were done by Greek philosophers, and indeed the term "meteorology" is said to come from a book called *Meteorologia* written by Aristotle in 340 B.C.

However, weather observation and analysis in early times was severely limited by lack of instruments. Apart from a crude rain gauge in India and a weathervane in Athens, there are few reports of instruments available in the pre-Christian era to assist in atmospheric observations.

It was not until the period of the Renaissance, with the renewed interest in scientific endeavour, that the basic weather observing instruments were developed. In 1597, Galileo devised the first thermometer, and Torricelli developed the barometer in 1664. During the same period, Hooke invented the anemometer to measure wind, and Boyle developed the gas laws governing the specific pressure and volume relationship of gases. Thus it was possible for the first time to quantify temperature, pressure and wind.

In Canada, the earliest recorders of weather were the explorers. As far back as 1534, the log of Jacques Cartier notes weather observations, and other explorers made similar rudimentary observations.

By the eighteenth century, with the basic meteorological instruments in use, the fur traders began to make observations and record them with surprising accuracy and detail. Missionaries and soldiers in charge of outposts along the frontier also took responsibility for recording temperature, wind and weather.

In the early years of the nineteenth century, amateur meteorologists in the larger centres of eastern Canada were recording temperatures and precipitation on a fairly regular basis. However, it was not until Christmas Day, 1839, that the first official meteorological observations were taken in Canada, at the Toronto Magnetic Observatory.

Although continuous daily observations have been made at Toronto since that time, it is ironic that the observatory was not primarily a weather station but was one of four stations set up as part of an international effort to measure the world's magnetism.

The next major milestone was the establishment of the Meteorological Service of Canada in 1871. Much of the credit goes to Professor G.T. Kingston, who was appointed director of the Toronto Observatory in 1855 and who persuaded the new Canadian government that a weather service was necessary to aid navigation and safety on the Great Lakes.

Almost immediately, Professor Kingston organized a small network of telegraphic stations from southern Ontario through to the Maritimes where weather was recorded at regular daily intervals and the information telegraphed back. He also established a network of climatological stations which reported back every month, and within a short time he had nearly 100 data-gathering stations in the network.

One of the earliest stations in Alberta was established at Fort Edmonton where daily observations of the wind, rain and temperature were taken starting July 11, 1880. Some of the early observations are missing, however, and an entry in the log explaining the missing data indicates the hazards of pioneer meteorology. The notation reads: "Fort gate locked prematurely; could not get out to take wind gauge."

The first weather forecasts in Canada were issued in 1877 from the central office in Toronto using the information telegraphed back from the network of weather stations. The forecasts, sent out at 10 a.m. (later 1 a.m.), were published in the afternoon papers and were posted in telegraph offices and post offices. As the railway and telegraph were pushed through the west in the early 1880s, the weather network also expanded west along the rail line, with an ever-increasing number of reporting stations established.

The expansion of the weather service alongside the railway and telegraph lines illustrates a central reality of the history of meteorology in Canada. Developments in transportation and communication — the telegraph, radio, radar, aviation, satellites and computers — have accompanied, made possible, and sometimes made necessary, developments in meteorology and climatology.

One of the most colorful if short-lived chapters in the history of Canadian weather forecasting was the use of "train weather

Expansion of prairie agriculture promoted the expansion of Canada's weather service.

Some things don't change — old and new rain gauges are variations on the same theme. For an even simpler version, see page 34.

signals" to provide weather information to farmers and others living within sight of the railway.

Upon receipt of the morning forecast by railway agents, large metal discs were hung on the side of a designated railway car. The shape of the disc indicated the weather expected that day. Farmers found the service a useful one, but within a few years the system began to break down as lax railway employees neglected to change the discs, allowing false predictions to be carried across the country. The system began to fall into disuse and before the end of the century had been entirely abandoned.

Until almost the end of the century, forecasting was centralized exclusively in the Toronto office. But with the increasng population of the west, a second office was opened in Victoria in 1898 to provide weather forecasts for British Columbia. Until the start of the Second World War, the offices in Victoria and Toronto issued all the public forecasts for Canada.

During the early years of the twentieth century, the weather service began a rapid expansion in the west. In Alberta in the 1920s, the development of the weather service was often part of a general expansion. Will Prusak, a climatological services specialist with the Atmospheric Environment Service (AES) notes that weather substations were sometimes set up and manned by the federal department of agriculture in conjunction with offices set up to look into problems of soil erosion and drought.

Just as the demands of shipping helped spur establishment of the meteorological service, so the expansion of agriculture and its dependence on the weather promoted the expansion of the service in subsequent years.

A major impetus to the growth of meteorology in Canada was the rise of aviation in the 1930s, particularly as the outbreak of the Second World War followed so closely. Aviation created a need for more sophisticated forecasting and also contributed to more sophisticated forecasting techniques.

Bill McKeown

The establishment of Trans-Canada Airlines in 1937 and the subsequent inauguaration of transcontinental air routes required the Meteorological Service to open new forecast centres throughout the entire southern portion of the country. In the west, according to Prusak, the prairie air mail service was an additional incentive. In Alberta, the first forecast centre was set up in Lethbridge in 1937 and was subsequently moved to Edmonton in the early 1940s.

Keith Hage, a professor of meteorology at the University of Alberta, feels it is difficult to overestimate the importance of aviation to the development of a forecasting network in Canada.

He says aviation forecasting and public forecasting are of equal importance. Most weather offices were established at airports, and weather information is "so important to aviation that many airlines have their own specialists working for them."

Meteorology in Canada received a big boost with the outbreak of the Second World War. Under the British Commonwealth Air Training Plan, 58 flying schools were set up to train air crews in Canada in the 1940-42 period.

Several meteorologists were required at most schools to handle the lecturing, forecasting and briefing duties, and the Meteorological Service also had to provide weather support to the RCAF and Canadian Navy. University graduates in science and mathe-

The advances in aviation during World War II led to a great expansion in meteorology.

Canada's Aviation Hall of Fame

matics had to be given crash courses in meteorology to meet the need. As a result, a staff of 27 meteorologists at the start of the war had expanded to more than 400 by the end. The wartime decision to build the Alaska highway created additional demand for meteorologists, a demand which had to be met in part by the United States forces.

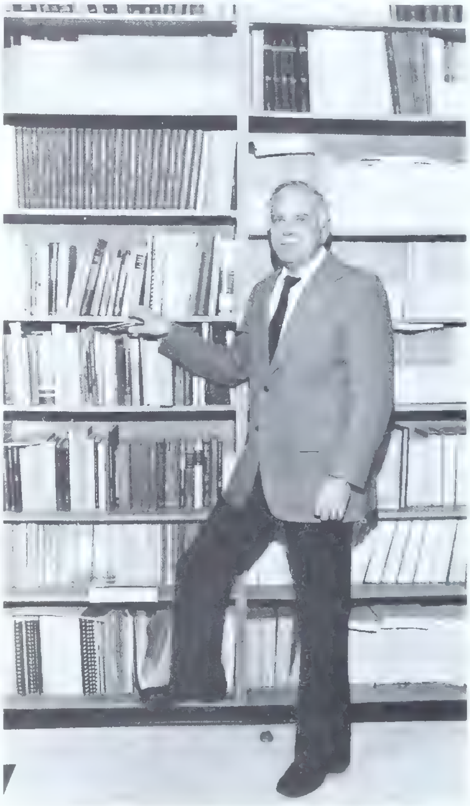
The demands of aviation for upper-air data in turn led to some important technological changes in meteorology. While aircraft themselves regularly sent back important weather data, radiosondes first used in Canada in the 1930s were another vital tool in aviation forecasting. (Radiosondes are a package of instruments sent aloft in a balloon with atmospheric information radioed back.)

Professor Hage describes radiosondes as "a major milestone in the history of meteorology", allowing continuous monitoring of the upper-level atmosphere through various altitudes. He also sees radar, first developed in 1935, as an important technological development which has been successfully applied to peacetime weather forecasting.

After the war, the meteorological service continued to expand in Canada to meet the needs of the civil aviation boom and to provide better services to the public. In Alberta, for example, the service was gradually expanded until today there is a network of 22 principal (synoptic) stations and more than 400 climatological stations, many of which are one-person volunteer posts providing only basic temperature and precipitation data to "fill in the gaps".

The post-war boom also saw a significant meteorological development into northern Canada. Starting in 1947, Canada and the United States established five Joint Arctic Weather Stations (JAWS) in the high Arctic, stations which have been under exclusive Canadian control since 1970. A couple of decades ago, a complete forecast service was established for the Arctic area through an office in Edmonton — the only one of its kind in Canada.

Through the 1960s and 1970s, major technological changes have led to an increasingly sophisticated forecasting service in Canada. To all of the traditional methods of gathering data we can now add the weather satellite. While Canada does not have a weather satellite of its own, it has had ready access to American satellite output for some years.



Bill McKeown

KEITH HAGE

Professor Hage of the University of Alberta says satellites are one of the important technological tools of forecasting today, giving us the "big picture" and filling in a lot of data which is difficult to obtain from remote places — over the oceans, for example. Moreover, as they improve over time, they could make more traditional data-gathering methods obsolete.

Nevertheless, Professor Hage says it is the computer, not the satellite, which has been the most revolutionary innovation for weather forecasters.

"The computer has changed the nature of forecasting," he says. "It can produce a whole series of maps as frequently as you want. It can produce maps of moisture, winds, anything.

"When the first computer was operational in the U.S., it revolutionized forecasting almost immediately. The computer has improved our forecasting skill to a range of five or six days."

In Canada, computers are used both for analysing information and producing maps, as well as gathering and transmitting data. The central analysis office in Montreal has had a large computer since 1962 which produces maps, and the regional offices including the one in Edmonton have smaller computers. In addition, 1970 saw the inauguration of a computer-controlled automated teletype system in the Toronto office for the collection and distribution of weather data.

The past decade has seen new responsibilities given to the meteorologist and climatologist in Canada. With the increasing recognition of environmental problems facing the world, the federal government in 1971 set up their environment department and renamed the Canadian Meteorological Service the Atmospheric Environment Service. The AES has an expanded role in pollution monitoring and in researching atmospheric processes affecting the environment.

At about the same time, provincial governments were establishing their own environment departments. Although the provinces have primary responsibility for environmental problems and pollution control, the information gathered by the AES is of considerable value to the provincial departments and agencies.

Thus it is that a national meteorological service has grown from one station with a budget of $5,000 and four employees in 1871, to a multi-million dollar operation with thousands of employees at more than 300 principal weather stations and almost 3,000 observing stations today.

Myron Johnson, a former CBC radio producer, is an Edmonton freelance writer.

R.C. MacKenzie

Forecasting

Behind the scenes of the weather broadcast.

Edmonton CBC-TV weatherman Larry Langley.

Heads, we'll get snow; tails, we won't. If weather forecasters used the coin toss method of guessing tomorrow's weather, half their predictions would be right. And half would be wrong. But modern-day meteorologists go about their jobs in a somewhat more systematic way, resulting in correct predictions about 80 to 85 per cent of the time. That's no mean feat when you consider what they're dealing with.

Most weather systems that affect us are found within the first 12 kilometres of atmosphere above the earth's surface. At any given time thousands of weather systems are churning about in this witch's brew — all six billion cubic kilometres of it. Trying to predict where any one of these systems might end up two days from now — or even this afternoon — has been compared with guessing the path of the ball in a pinball machine.

Before a forecaster can predict where weather systems will go — and when — he needs information. Lots of it. Weather systems must be probed, analyzed and characterized in terms of temperature, pressure, humidity, visibility, wind speed, wind direction and cloudiness. Systems must be located geographically and their past history — where they were yesterday or two days ago — must be known. To do this, thousands of so-called "surface observational stations" are located around the world on land and sea. Many are staffed with observers around the clock. Others report their data automatically: for example, buoys on the oceans, and in the case of Canada, on the ice pack off the Arctic coast. But, as impressive as this network of ground stations is, it covers only about 20 per cent of the earth's surface, causing most of the planet to be what meteorologists call a "data-sparse area".

In southern Canada — where most of us live — observing stations are usually positioned so that no point on the map is more than 100 kilometres from a surface station. In northern areas stations are located about 500 kilometres apart. This means the "grid" of stations in the settled areas of Canada is sufficiently close that most weather phenomena can be detected. Nevertheless, an occasional thunderstorm can develop in the space between two stations, soak a few souls and then disappear without ever being detected by a ground station.

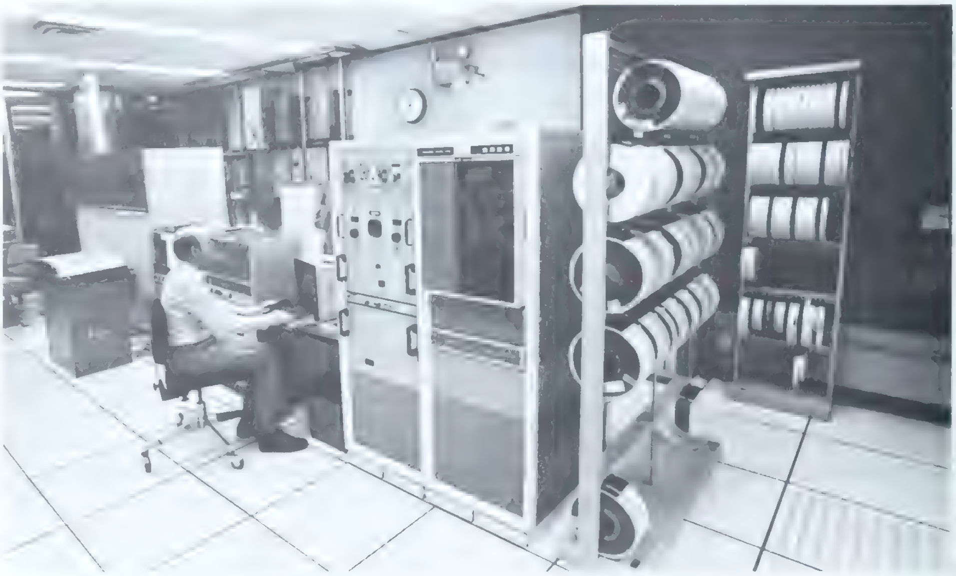
To supplement surface observations, an upper air network of stations samples the atmosphere up to about 30,000 metres using instrumented balloons (called radiosondes) that measure and then radio back to ground stations such properties as air temperature, pressure, humidity, wind speed and direction. Upper air stations, like the one at Stony Plain near Edmonton, are spaced much more widely than surface stations. This means the upper air grid has "holes" in it that are several hundred kilometres in size, allowing more opportunities for smaller weather systems to move through the net without being measured. Satellites fill in these gaps, by observing these "data sparse" areas as often as every half hour.

This reporting network of surface, upper air and space stations allows about 140 countries to share their observations through the auspices of the World Meteorological Organization, an agency of The United Nations. For example, weather data used by Environment Canada forecasters at the Alberta Weather Centre in Edmonton will be a mixture of information from Canadian sources as well as from the U.S., U.S.S.R., Greenland and Iceland. So that some basis for forecasting can be used universally, all observation stations measure and report their data at specified intervals, measured according to Greenwich Mean Time (G.M.T.). Using the zero degree meridian passing through Greenwich, England as the reference point for all time zones, data are reported every six hours at 0600, 1200, 1800 and 2400 hours G.M.T., thus providing composite "snapshots" of earth's weather at those four moments.

But, once every six hours is not often enough for many users of weather information. Consequently, nearly half of Canada's

Meteorological technician reading a printout from a minisonde recorder for a vertical temperature profile.

Environment Canada



Environment Canada's communications centre, western region.

B. M. K[illegible]

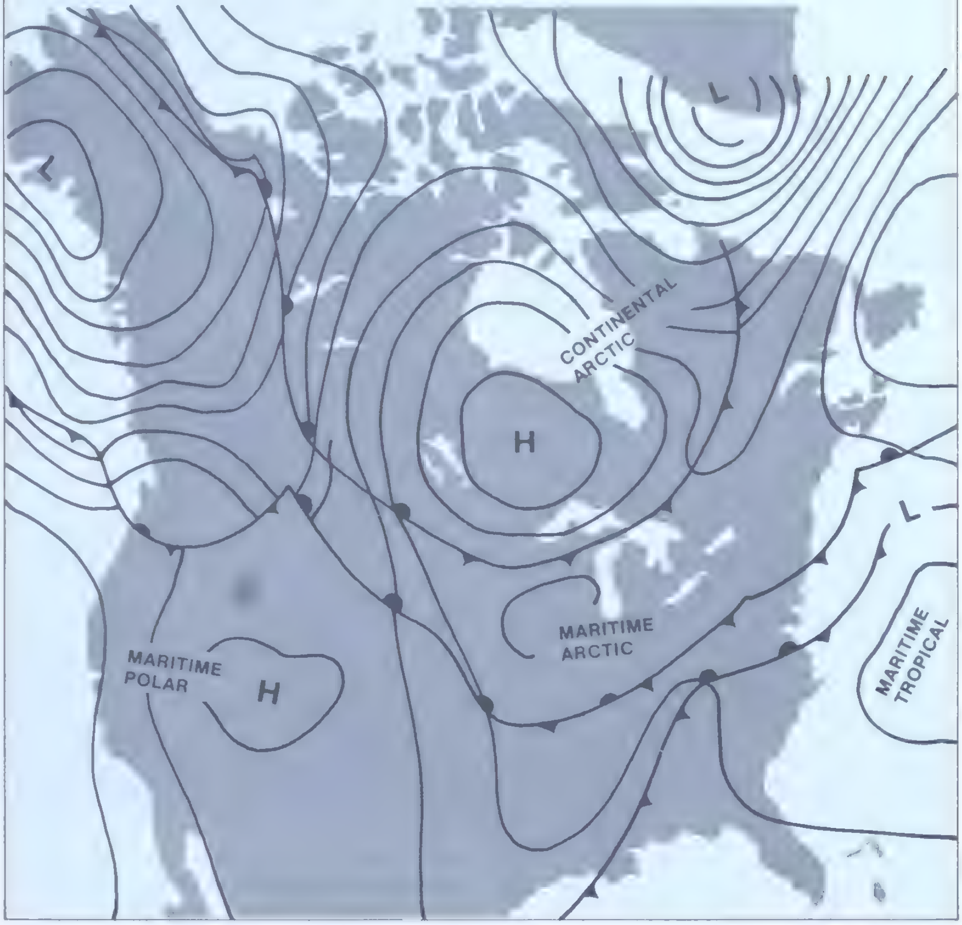
300 observation stations report their measurements hourly. Information stored in computer terminals at each station is transferred automatically to Environment Canada's central data switching facility in Downsview, Ontario, during the first seven minutes of every data collection hour. The off-shore buoys radio their findings to satellites and thence to Downsview. Once the data are processed they are organized by the computer so they can be readily useful to meteorologists and then sent out to weather stations across the country. In the meantime, the same information is passed on to the Canadian Meteorological Centre (C.M.C.) in Montreal where computer experts have developed incredibly sophisticated mathematical representations (or models) of the earth's atmosphere. Using incoming data, some of the world's largest computers at C.M.C. produce maps of the atmosphere at various altitudes showing pressure systems, winds, areas of precipitation and other forecasts of where weather systems are expected to be for the next five days. In the 1920s, when some of the mathematical equations were first developed, meteorologists were unable to put them to much use because it would have taken a staff of thousands just to handle all the calculations needed to process data in time to make a meaningful forecast. That's some measure of how far computers have brought the science of forecasting, with most progress having occurred since the 1950s.

Computer-generated weather maps are distributed to Environment Canada's weather stations by facsimile machine. In this way the Alberta Weather Centre receives data routed through Downsview and forecasters also learn what the computer in Montreal predicts from the data.

In the meantime, two American satellites have been orbiting the earth from pole to pole. Every six hours one of these satellites passes, sending back information in pictorial form about clouds, temperature and even sea ice in the Arctic Ocean. That means meteorologists can have a visual or infrared picture of cloud patterns larger than one kilometre in size making the satellite's grid spacing about 100 times closer than that of the surface station network. And if satellite photos are required more often, two geostationary satellites "parked" over the equator will oblige every half hour. Called GOES-East and GOES-West, they show views of the northern hemisphere in less detail than

Where the Action is

A simplified version of a computer-generated weather map



the orbiting satellites but provide valuable information on the movement and development of weather systems.

When it comes time to make a forecast, the meteorologist will refer to computer-generated weather maps, data supplied by observing stations, satellite photos and weather radar, the latter being used to locate areas of heavy precipitation.

"From that point on", says John Bullas, Environment Canada satellite meteorologist, "we use traditional methods of analysis. Once we've found the weather systems we use the computer to move them from where they are now to where we think they'll be a day or so from now, moving the weather with them. During that process we stir in our knowledge of how similar systems behaved in the past as well as our knowledge of how the atmosphere obeys certain physical laws.

"But that's not the end of the process. We know our predictions have to be fine tuned as weather systems get closer, where we can take a better look at them. Suppose, for example, we see a low pressure area coming in from the middle of the Pacific and then predict it will be over Winnipeg in 48 hours. If that system should veer north of Winnipeg by 50 kilometres it would mean the weatherman was wrong to someone living there, but we think we're pretty accurate to be out only 50 kilometres over a track of 6,000 kilometres!"

Bill McKeown

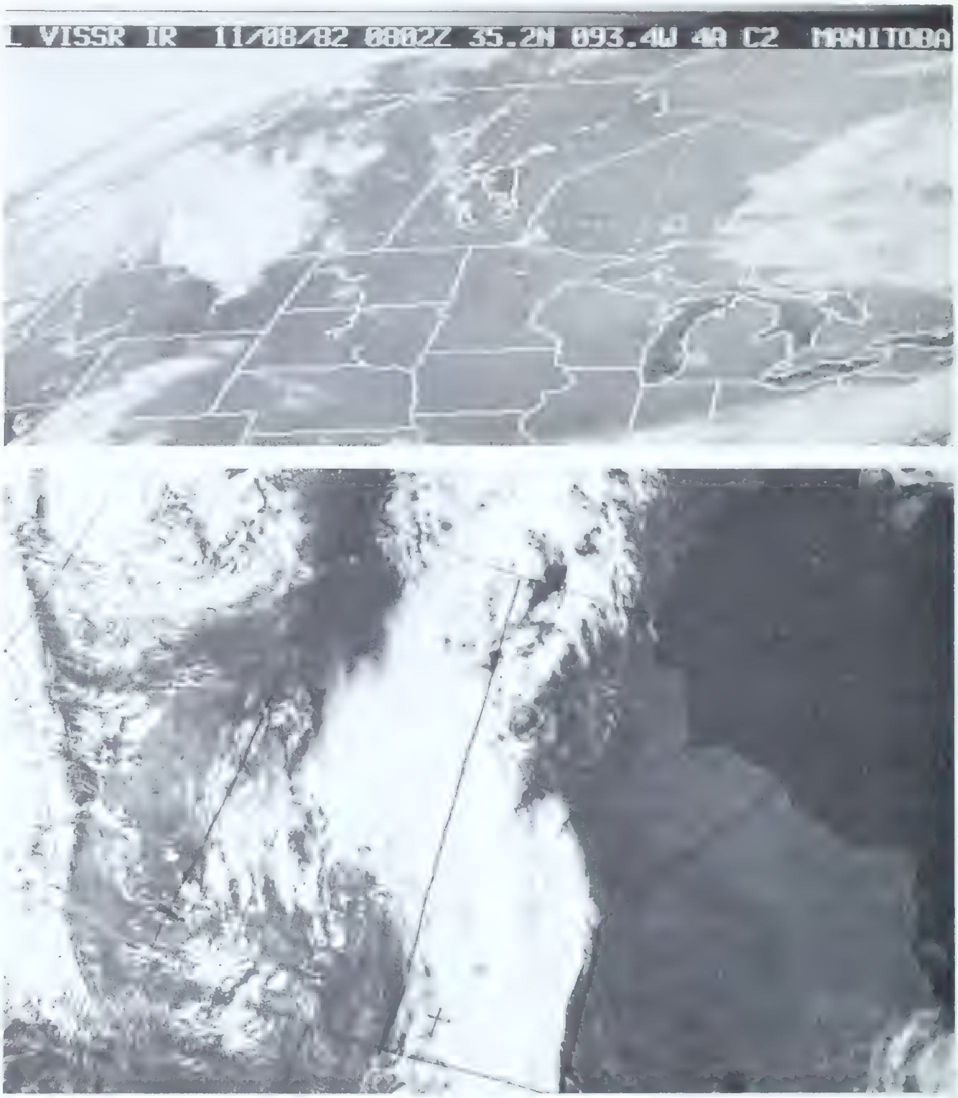
JOHN BULLAS

The solution is to continually update the predictions. That's why meteorologists like to distinguish between "official forecasts" and "outlooks". "Forecasts" contain details such as probability of precipitation, high and low temperatures, wind speed and direction and timing of the arrival of weather systems. These are made only for the next 24 hours. Anything beyond that is an "outlook" and is far less detailed. For example: "The outlook for Thursday is sunny and warm".

Once he has made his prediction, a forecaster is faced with another challenge: wording it so that people will understand what he means.

Recently, Environment Canada has been issuing percentage probability of precipitation forecasts, which mean the probability of measureable precipitation occuring *at any particular point* in the forecast region. Alberta is divided into 15 regions. An example: if there is a 30 per cent chance of precipitation today for the Red Deer region, it does not

These two satellite photos show the progress of a storm across the prairies. As recorded by a geostationary satellite (above right), the storm is centred over Alberta. The next day, as recorded by an orbiting satellite, it had moved into Manitoba.



Environment Canada

What the Weatherman means when he says . . .

"Clear" — less than 4/10 of the sky covered by clouds.
"Sunny" or **"A few clouds"** — less than 70 per cent of the sky covered by clouds.
"Cloudy" — 70 per cent or more of the sky covered by clouds.
"Mainly (sunny/cloudy)" — indicates the predominant condition expects over a period of time.
"Showers" are short periods of precipitation with intensities that can vary from light to heavy. Each shower affects only a small area and it is impossible to predict exactly where it will occur. In the winter season the term "snowflurries" is used to describe this condition.
"Chance of a shower" means that the likelihood of occurrence at any one point is less than 50 per cent.
"One or two showers" means that the likelihood of occurrence at any one point is greater than 50 per cent.
"Frequent showers" means that several occurrences are expected at nearly every point in the region.
"Risk of (freezing rain, hail, frost)" is used for hazardous weather conditions to indicate that there is less than a 50 per cent chance of occurrence.

If winds are not included in the forecast they are expected to be generally below 20 km/h. However, lower speeds may be forecast during cold spells or to indicate changing weather conditions.
"Moderate" winds indicate speed in the range of 20 to 40 km/h.

Temperature trends included in "outlooks" indicate the expected change from the previous day.

mean that 30 per cent of the region will get wet; rather, that any one point — your back yard, for example — has about a one-in-three chance of being rained upon.

Even with the most careful wording, the forecast can be weakened when media reporters and announcers place their own interpretation on the forecast rather than reporting it just as it was written.

But despite these obstacles, demand by the general public and other clients for weather information has led to the introduction of Weatheradio Canada, a 24-hour, continuous weather broadcast on the VHF/FM band from major Canadian centres, including Edmonton. Another will be operating soon in Calgary.

Public weather forecasting is only one of many services provided by Environment Canada. Others include aviation weather, marine forecasts and specific information related to agriculture and forestry, as well as off-shore ice conditions required by drill ships and rigs. Weather information has become so vital for many resource-based activities that provincial government agencies, industries and consulting firms now employ their own meteorologists.

Meteorologists are under increasing pressure from industries and government agencies to provide monthly and seasonal forecasts. With very long-range forecasts, preparations could be made in advance to deal with such phenomena as long cold spells, droughts or floods.

An important step toward developing the capability for long-range forecasting was made in 1978, when many experts in the climatology field were brought together at Environment Canada's Canadian Climate Centre in Downsview. Their aims are to improve our understanding of the climate system, develop the ability to forecast climate on a monthly, seasonal and annual basis (or longer) and predict the effects of man's impact on climate, in particular the production of large quantities of carbon dioxide caused by combustion of fossil fuels in our homes and factories. Clearly, their challenge is enormous but the correct prediction of even one major climatic event could be of tremendous value to those affected by it.

R.C. MacKenzie is the former head of the solid waste section of Alberta Environment's waste management branch. He now operates a communications firm in Edmonton specializing in science and technical writing

Jim Wilson

Measuring Climate and Weather

Better measurement techniques mean better forecasts.

For thousands of years weather and climate were unmeasurable quantities: After all, what mere mortal would dare measure something that was the work and whim of his gods?

Then came those canny Greeks, who in response to the requirements of their farflung maritime operations began publicly posting weather measurements and observations in seaports, as early as the 5th century B.C. And shortly after, Aristotle probably became the first meteorologist (misguided through he certainly was) when he wrote in *Meteorologica* that weather was the predictable result of processes which transformed what he said were the four elements (earth, water, fire and air) into one another with catalytic help from the Sun.

Aristotle's theories were a bit off base, but in about 300 B.C. his student Theophrastus compiled all the contemporary weather lore into one volume, called *The Book of Signs*, thus becoming the first published climatologist.

He described more than 200 observable and measurable portents of weather changes in the long and short term, and while these included such exotica as the strange behavior of sheep and crawling patterns of centipedes, they also included concepts used by today's much more scientific weather people — and which have stood the test of time. For instance, he was the first person to codify the mariner's observation, "Red sky in morning, sailor take warning; red sky at night, sailor's delight" — which today's specialists say has about a 70 per cent probability of being correct.

Bill McKeown

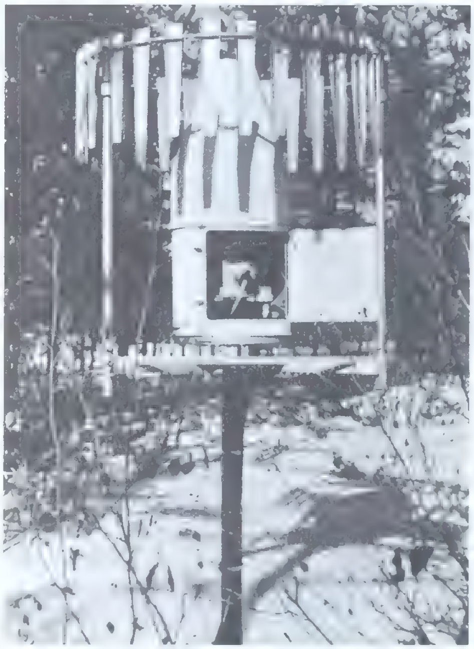
BRUCE THOMPSON

It took about 2,000 years of undoubted vilification for weathermen to finally adopt real scientific devices and techniques, but once they got with it, their affection for new-fangled methodology became absolute.

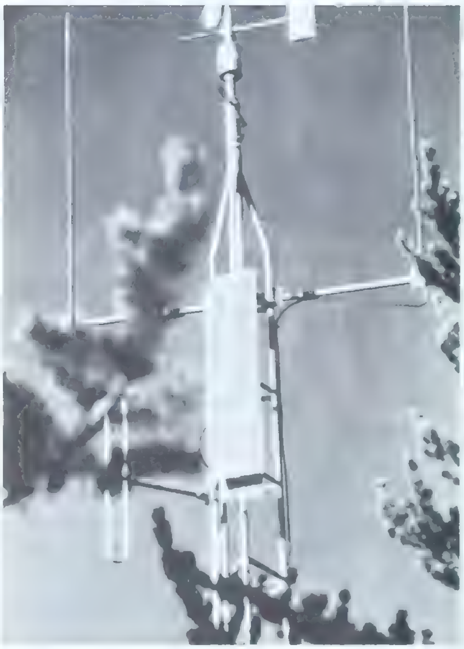
Where the meteorologist of a few centuries ago combined a couple of temperature readings with his own knowledge and reference to a number of almanacs, today's specialist is supported by satellites, computers, an army of measuring devices, very specific guidelines, years of experience, instantaneous communication with stations all over the world — and still, almanacs describing past weather performance.

"But even with all that support," says Bruce Thompson, scientific services meteorologist in Environment Canada's Edmonton weather office, "even with all our improved knowledge, we still can't say we're really accurate for more than a 24-hour period."

Arjen Verkaik



Environment Canada



Environment Canada

A summer fireworks display over the prairies.

A snowfall collector. Baffles keep blowing snow out of container (below left).

A solar collector on an unmanned weather tower of the Atmospheric Environment Service powers communication equipment. The solar energy is stored in underground batteries at the base of the tower (below right).

Just to get that 24-hour accuracy, a staggering amount of data is collected. While 25 or more different kinds of observations are taken (most of them every hour, some less frequently and a few half-hourly), the forecaster works from a standard weather report offering him eight specific sets of figures which describe the situation as it currently exists:

- cloud layers, and how high they are
- precipitation
- visibility
- surface and atmospheric pressure
- surface temperature
- dew point
- wind direction and speed
- cloud amounts: how much of each type

To provide this information, telephone and radio links are used to draw information from several weather satellites, ocean-going weather ships, balloons and literally thousands of ground-based manned and automatic weather stations worldwide. Complex computer systems masticate the resulting bits of information and the results are transmitted to both domestic and international weather forecasting centres.

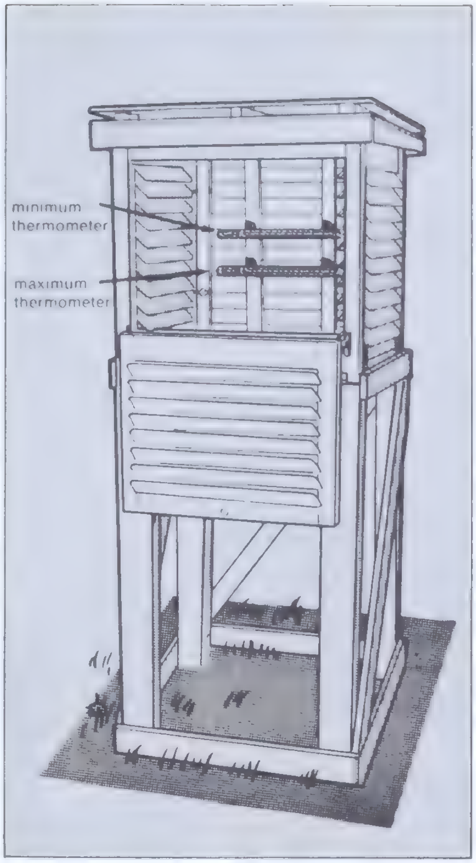
The computers are loaded with special diagnostic models which numerically simulate the earth's atmosphere. As new data arrive, this model changes form accordingly, providing an up-to-date picture of the weather.

Other computer programs can take these models, and through "what-if" questions and data predictions, provide meteorologists with some idea of what changes are likely to take place in the weather picture in following hours. Eventually, all this information, together with special weather maps and pictures, filters down to the local forcasters, who then apply their own knowledge to creating local outlooks.

While the tools used have been refined, and the communication techniques dramatically improved, many of the instruments would likely be quite recognizable to their inventors of years and even centuries past, although they may now be mounted in a satellite, an automatic ground station or be part of a radiosonde's balloon payload.

Cloud heights are needed for several meteorological purposes, particularly in warning of and identifying the location of moving weather fronts. However, they're also vital to the aviation industry, and curiously enough this provides meteorology with one of its three major measurement system anomalies: because of international agreements, cloud heights are reported in feet, not metres, even though they're measured metrically.

Three instruments may be used. A ceilometer, which in effect beams a radio wave upward at the cloud cover, is similar to radar, with the returning signal bouncing from the clouds and providing a time-and-speed calculation to indicate cloud altitude. Another instrument is a ceiling projector, used only at night, with which a bright light is aimed at the clouds, and its reflection detected by another instrument located a known baseline distance away. Triangulation is then used to calculate height. In other circumstances a balloon is used: It's filled



The Stevenson Screen is designed to protect thermometers from the direct sun, precipitation and heat radiation from the ground.

with a measured weight of helium so that it will rise at a known rate, usually 130 metrs per second. The meteorologist watches the balloon's ascent, timing it until he sees it vanish into the clouds. This time-and-speed value is used to calculate cloud altitude.

Meteorologists can also take visual readings of what they term "low," "medium" and "high" cloud layers. The category is based on the actual type of cloud as identified by the observer — stratocumulus, for example, is generally below 2,400 metres.

There's also a relatively accurate calculation any of us can use in the summer: temperature minus the dew point multiplied by 71 gives the approximate cloud base height in metres.

Precipitation measurement provides the forecaster with some idea of how much rain or snow is currently falling in a given period, usually 24 hours, and where it's falling. Several forms of rain (or snow, or heaven forbid, hail) gauges exist; all rely on collecting precipitation over a broad area and measuring the amount of liquid thus produced. Used in conjunction with other observations, this provides the forecaster with knowledge of moisture moving into his forecast area.

Visibility, another factor important to aviation, establishes how far away objects can be seen with clarity. The usual form of measurement is visual: recording whether or not objects a known distance away from the station can be seen. At night, complicated instruments based on photoelectric cells are frequently used, although a bright light (as along an airport runway) shining from the same objects observed during the day will generally suffice. The results are reported in feet or miles, but meteorologists generally consider them in metric measure. Visibility indicates ground-level atmospheric conditions to the forecaster, providing very localized information for him when he needs it. Fog banks or blizzards are the sort of thing this value records.

Atmospheric pressure is an important meteorological measurement. The earth is actually covered by an enormous ocean of air, with all sorts of things happening in it all the time. One of these is rapid variation in pressure in a vertical column of air. For instance, since cold air is denser than warm air, the cold air rises — and how air movement is developing because of these pressure changes helps the forecaster to identify moving weather fronts so he can estimate what's going to happen next in his own area.

Surface pressure is also important to the forecaster, because it provides him with his basic ground-level weather map, which indicates what's going on near the surface, all over the region (and anywhere else he feels he needs to look). The map's isobar outlines define pressure gradients in the region.

Pressure is recorded with several forms of barometers, which measure the effect of varying pressures on a column of liquid, usually mercury. The atmospheric pressure forces the liquid upward in a tube of known diameter, and the pressure is thus measured as the weight of the liquid that's been forced into the tube above a point that would indicate the zero-pressure of a vacuum. Just to confuse things — and to provide a worldwide common baseline for all surface pressure reports, these readings are always converted to sea level equivalents at the specific point of observation.

Surface temperature, measured by fairly ordinary thermometers at most stations, provides the forecaster with an idea of how the air is being affected by or is likely to be affected by surface heat — which is dependent on the amount of sunshine that has reached the surface.

Dew point — the temperature to which air must be cooled to become saturated with moisture — is measured with a hygrometer, and the reading provides the forecaster with knowledge of how severe weather conditions may develop. For instance, fog can develop where the temperature drops below the dew point; if the temperature drops below freezing, the result is frost. The forecaster needs this information to round out his outlook when he issues it to the public.

Wind speed and direction provide the forecaster with an idea of how fast weather patterns and fronts are moving, and in what direction. The anemometers and other wind evaluation instruments are among the most complex of surface hardware. Direction, read by elaborate tools that are simply weather vanes grown magnificent, provides readings in degrees, measured clockwise from geographical north. Wind speeds are reported in knots for the aviation industry, although for forecasting purposes they're recorded in kilometres per hour.

Cloud types tell the forecaster what to expect in the way of precipitation and movement of different kinds of weather fronts, since their appearance is governed by what's happening in the air volume they exist in. They're recorded by visual observation. When the forecaster sees indications of altocumulus cloud moving in his direction, for example, he knows that he should look closely for other indications that would make thunderstorms possible. Amounts of cloud are recorded in terms of the percentage of the sky they cover.

For more detailed weather records, various measurement devices also analyze other meteorological items. Air temperature is taken at numerous altitudes; temperature readings are also taken below the earth's surface at several levels down to 100 centimeters. Relative humidity is measured; speed of evaporation of moisture is established; sunlight duration is recorded; even pollution and pollen counts are established. In some areas pyrheliometers and pyrradiometers are used to measure direct solar radiation, sky radiation, global radiation

High cloud over the Rundle Range of the Rockies.

and terrestrial radiation to assist in establishing the net gain or loss of heat experienced on the planet's surface at a given place and time.

At present, the weatherman has a fair degree of confidence in his 24-hour outlook, a lesser degree of confidence in his second- and third-day forecast and very little confidence in his fourth- and fifth-day predictions. But at least to some degree, that should change in the next few years as measurement techniques and computer procedures improve.

"I think climatology will give you as good a prediction at five or more days as our existing techniques can," says Gene Prozny, officer in charge at Environment Canada's Calgary office. "But our whole system is being improved now and we're getting in a new generation of computers that will provide faster and more accurate information for our forecasters. I think within the next 10 years we'll be getting much better confidence in our third, fourth and fifth-day forecasts, and maybe even into a sixth day."

Prozny is looking forward to installation in Calgary of a new weather radar system next year — worth in excess of $1 million — that will for the first time provide his staff with the capability of searching the atmosphere around Calgary for special local data. At present this kind of information comes from a similar system in Edmonton, which is a bit too far away to ensure accurate results. Weather radar systems have a range of about 3000 kilometres, and provide minute-by-minute data on that area's weather movements — an enormous advantage over current hourly readings taken by human observers and automatic systems.

New weather radars are being installed at numerous points across Canada. When coupled with upgraded computer systems, and the likelihood in a few years of each forecasting station having its own computer system tied directly into the major Environment Canada computers in Montreal and Toronto, this will have far-reaching effects on forecasting capabilities.

Bill McKeown

GENE PROZNY

Bruce Thompson agrees with Prozny that things are finally improving. "The network of observation stations we have now has been in existence for years, and we use only tried and true techniques. But we're now at the point of using new computer systems and much improved satellite sensing instruments to get faster observations. Satellites provide us with data about areas we previously couldn't observe very well — the Arctic, for instance, and Africa. This gives us a much better idea of the scope and power of weather systems as they move around in the atmosphere."

Satellites also provide the weatherman with good pictures of cloud cover over oceans which were previously studied only by a few weather ships, and infra-red and ultraviolet pictures as well, which outline in detailed form the various cloud decks and what's happening in them. Satellites have also solved one of the meteorologist's largest frustrations: how do you see what's happening in a storm when you're inside it and your view and the view of many instruments is obscured by snow, rain or clouds. Satellites — and weather radars — can provide the pictures required for effective interpretation.

Climatology, which in this aspect is essentially a historic list of daily and longer-period weather reports and trends, is also an important forecasting tool, one whose accuracy improves as experience with it lengthens.

"We get all sorts of fantastic details about what's going on around the world," Bruce Thompson says, "but when you're forecasting for a particular area you have to be aware of the types of weather and patterns you can expect. That's when climatology becomes important. For instance you can use historic measurements to help you decide on any given day what the probability in your area would be of having four sunny days in a row, because you're certainly not going to have sufficient information from your observations to make that decision."

One area where dramatic improvements in forecasting accuracy have already been made is in predicting Alberta hailstorms.

"Weather that occurs on a short time frame and in small space scales is extremely difficult to study," says Brian Barge, head of the Alberta Research Council's atmospheric sciences division. "Hail is our best example of that sort of severe weather here — it occurs most frequently in a relatively small area in a belt between Red Deer and Edmonton, and from the mountains to around Highway 2 and at times almost to the Saskatchewan boarder."

Bill McKeown

BRIAN BARGE

Because of the small area and the speed with which hail storms can develop, there are fewer observations to work from because the storms and their indicators can develop between the hourly observation times and in areas not immediately served by any form of weather measurement station.

"Nevertheless," says Barge, "we've learned enough and developed enough observation stations in the critical area that we have an accuracy of about 80 per cent in hail forecasts on a daily basis."

A helium-filled balloon called a radiosonde carries instruments into the atmosphere.

Hail is a dramatic example of what's sometimes termed "microweather," measurement of which is extremely difficult. Fog, late-spring snow, other isolated snowstorms, tornadoes, other heavy winds are others. Every time a new road is built, or a new building, or new land farmed or logged, or a hill is levelled for construction, the area's microweather factors are altered.

Measuring these smaller weather systems and assessing what their impact on a larger region is likely to be is generally accomplished by unmanned, automatic weather stations — both in remote areas where such weather activity may start, and in the immediate areas where the environmental changes are under way.

Lorne Murton, supervisor of special projects and acting superintendent of inspection services for Environment Canada's Edmonton office is one of the men who installs and services remote stations. Some are manned, such as one at Fort Reliance on the east end of Great Slave Lake. Others, such as one at Port Radium, are automatic. Most of these stations provide only basic observations — temperature, pressure and humidity — but some are fairly sophisticated.

"We also have a really extensive network of precipitation gauges," Murton says. "They're all automatic, and some of them use satellites to transmit their data to the computer in Montreal. Others use phone lines or radio communications. And they all have to be manually inspected every three months."

Jim Wilson is a Calgary freelance writer and editor

COMMENTARY

by Alex Mair

If you were looking for a characteristic common to most Albertans, their attitude towards the weather would proabably do the trick.

Albertans have a strange attitude towards the weather, but they don't realize it, and that's what sets them apart from people from other parts of the world.

There are a great many Albertans who bought copies of Margaret Atwood's book, "Survival," on the assumption that it was an instruction book that would help them to cope with prairie weather.

Where else but in Alberta would you find a family quite willing to go out and spend more than $800 for a two-toned, self-defrosting, combination refrigerator and freezer which, for nine months of the year, will keep their leftover sauerkraut at a temperature approximately 21° *warmer* than the outside air?

An Albertan thinks that the ultimate summer status symbol is a self-propelled lawn mower upon which he can sit and ride while he cuts the grass. And if he can afford it, he thinks nothing of spending $2500 for one, which he will use to cut the grass for six weeks every summer. And for the other 46 weeks of the year? He'll clear his walks and driveway with a sheet metal snow shovel that he bought for $7.98 because it was on sale.

The defensive attitude towards weather creeps into our conversation, particularly during the winter months. One Albertan will ask another about holiday plans for the winter months ahead. He won't ask his friend if he's going to take a winter holiday. He'll ask him if he's going to 'get away' this year. That's the way one lifer in Sing-Sing talks to another lifer when he knows there's a jail in the offing.

Even during the summer months we approach our weather with a somewhat defensive attitude. One of the more popular sports in this part of the world involves strapping an ironing board onto each foot, holding onto one end of a rope which is attached at the other end to a motor boat, and then allowing yourself to be hurled across the surface of a prairie lake. With *luck* you're on the surface. If not, well, I met a fellow who told me that he'd tried it once and passed three jackfish on the way down. It can be a lot of fun, but why do we insist on calling it water *skiing*?

We just can't seem to shake that snowflake syndrome.

During the warm weather the average Albertan acts as though he's expecting the whole thing to be snatched away from him without warning. If he hits a hot weekend, he'll try and soak up a summer's suntan in one afternoon. He ends up looking like a hairy mail box and can't move for a week, but he never complains and the rest of us seem to take his behaviour for granted.

We Albertans take the same strange defensive approach to our winter sports as well. Albertans, by the thousands, flock to the curling rinks every winter to take part in one of their favorite winter sports. But where else in the world would people stand out on a sheet of ice with cold feet, cold hands, a runny nose and a sore back being yelled at by someone who's complaining because you're not sweeping hard enough?

When W. O. Mitchell called his first novel 'Who Has Seen The Wind' he either had his tongue in his cheek or was talking about Albertans. Perhaps both.

If you're outside on a spring day, you can *easily* see the wind because it's full of sand, gum wrappers, cigarette packages, plastic bags and trolley bus transfers. You can not only *see* the wind in the spring, you can *taste* it.

We spend all winter shovelling sand onto the city streets so we can stop and go, and all summer sweeping it up so we can see and breathe.

Albertans are very fond of telling people from other parts of the world that our weather isn't really a problem as long as you dress for it. That means you can wear next to nothing during the summer and in the winter, dress up like the Abonimable Snowman. I think we tend to assume that people the world over look a little like Nanook of the North when they put on their parka and take out the garbage.

And an Albertan sees nothing incongruous in standing beside his car on a bitterly cold February morning. The temperature is hovering around the -40 mark, whichever scale you're using. The wind is out of the northwest at a Force Four Gale. The car windows are covered with frost, the block heater cord has come unplugged during the night, the keyhole is forzen shut, the battery is dead and the tires are square, and yet, our boy, in answer to the shouted greeting from his neighbor who has just been transferred in from British Columbia will say,

"Yes, but it's a *dry* cold."

Alex Mair is an Edmonton humorist whose column appears in the *Edmonton Journal*.

Susan Brun

Susan Brun

Susan Brun

by Helen Corbett

Weatherlore

"Red sky at night, sailor's delight;
Red sky in the morning,
sailors take warning."

JOY AND LOUIS KAMENKA

If you've lived in southern Alberta any length of time, chances are you've heard the one about the farmer and the chinook.

It seems a farmer and his wife drove to town one crisp winter day when a chinook blew up. The farmer put his wife in the back of the sleigh and started home at full gallop. As hard as his team raced, the front of the sleigh slid on the snow while the rear runners dragged in the mud.

By the time they got home, the farmer was frozen and his wife had sunstroke.

With its extremes of weather, the prairies have cultivated quite a literature of tall tales, folk beliefs and plain old superstitions regarding the weather. And when it comes to predicting weather, there's still the odd person around who can forecast an oncoming storm by the color and texture of the sky, smoke hugging the ground or the behavior of animals.

These visual clues are just part of the vast field known as "observation forecasting," or the casual art of weather watching based on thousands of cues from nature. (Ben Franklin on the subject: "Some are weatherwise, some are otherwise.")

Louis Kamenka is among the weatherwise. As a blacksmith in the now-closed Canmore coal mine, and a longtime trapper, Kamenka learned to use natural signs to gauge what kind of winter lay in store for the area.

He observes how a colony of squirrels stores its cones for the winter:

"In a normal winter the squirrels will pile their cones outside," he says. "But if the winter is severe, they'll cut them early and bury them underground, so they don't have to come up to eat. As a result, their furs don't reach their prime as early."

Kamenka's observations are in the category of long-term forecasting — using a reading of natural signs to predict the severity of a winter or a summer's rainfall.

This controversial branch of weather lore has a whole literature of its own: severe winters can be predicted by measuring the width of the black band on the woolly bear caterpillar, the berries on the hawthorne or mountain ash, the size of the beavers' house and so on.

In earliest spring, the lowly groundhog is called on for his forecast. This tradition (the latest incarnation of one which has used such other hibernating animals as the badger, bear and hedgehog) calls for the groundhog to peer out of his hole on February second. If the day is bright, he sees his shadow and is frightened back into his burrow for another six weeks of winter. If Groundhog Day is overcast, the little fellow is supposed to stay out for a while, and the rest of us should look for spring around the corner.

Summer, too, has its prognostications.

If it rains on St. Swithin's Day (July 15),
It will rain for forty days straight.

Both of these traditions are of limited usefulness in their countries of origin and even less useful when transplanted to North America.

Meteorologists tell us that much inaccurate lore stems from trying to predict an entire season from the vantage point of late fall or early spring. Says Hage: "I don't put much stock in long-range predictions. Looking at past data, in my view they have no scientific merit. I don't know anyone, scientist or otherwise, who can accurately predict weather beyond one week."

Far from being frightened by the sun, this fellow seems to be enjoying the Groundhog Day rays at Edmonton's Valley Zoo.

Dave [illegible], Edmonton Journal

Still man has a need to predict; to know what winter holds in store for him, even if it is wrong. How else to explain all those predictions we read in the newspaper every autumn forecasting a long, hard winter?

Let the editor of 49 annual editions of The Farmers' Almanac explain: "It's comforting to know ahead of time about the next season," says Ray Geiger of Lewiston, Maine. "Most people have a built-in forgiveness for the almanac. When we're wrong they forget about it, but when the meteorologist is wrong, he gets clobbered."

Perhaps that's one of the reasons almanac sales keep increasing in an age when the responsibility for forecasting is left to modern science. Circulation of The Farmers' Almanac alone has increased from 86,000 when Geiger took it over in 1934 to six million last year.

As for accuracy? "Well, people tell us we're 80 to 85 per cent accurate," he says, "but I probably wouldn't give us as high a credit myself."

Geiger won't divulge the "secret formula" that allows him to peer into our atmospheric future. Only five people have been privy to the formula in the almanac's 166-year history. The knowledge is now safely in trust with the present almanac astronomer Caleb Weatherbee, "an old almanac name."

Almanacs do, as a rule, rely on some ancient techniques to come up with their equations. Since their inception in Egypt around 3,000 B.C., almanacs traditionally linked the time to sow specific crops with the appearance of certain star formations. Today, they employ astronomy, cyclical theories of weather development, sunspot activity and records of weather for specific dates in the past.

Seasonal outlooks are only part of the weatherlore picture. The weather wise have a higher success rate with the day-to-day business of weather forecasting. Kamenka's wife Joy, for example, doesn't wait for the radio weatherman to tell her what sort of a day to expect.

Every morning without fail, she glances out the kitchen window for the weather forecast. No matter what the radio may predict, she has her own weather gauge in Three Sisters' Mountain, looming over the old coal mine.

"For 30 years I've been checking Three Sisters' every day," says the retired nurse. "When the clouds fill her in, there's a storm coming."

The inevitable question arises here. Why rely on such old-fashioned beliefs when today's weather forecasting is backed up by sophisticated radar and meteorological satellites? Isn't weather lore just a pile of superstitions and fears?

While some of our weather wisdom *is* based on superstition, much of it is based on generations of careful observation of the environment. Indeed, many weather proverbs have been validated by our scientific understanding of the atmosphere.

And, as we all know, the modern weather forecast is not infallible. Haven't we all been caught without an umbrella when the forecast calls for clear and sunny weather? Weatherwatching, when used in tandem with the meteorological forecast, can give us a reliable short-term idea of what lies ahead.

"An insight into the weather can be especially important for the backpacker," says outdoor survival instructor Mors Kochanski,

Susan Bruin

Susan Bruin

MORS KOCHANSKI

who has taught at the Blue Lake Centre near Edson since 1969.

"Misreading the weather can lead you into a lot of trouble. It can mean the difference between venturing over the pass or staying by the river."

Taking his students into the bush for a month at a time, Kochanski teaches them basic signs of reading the sunset, the dew on the ground or the direction of northeast storm winds. Much of this comes from a savvy bred by years outdoors, says Kochanski, and "it's often hard to verbalize that instinct that tells you it's going to rain."

Traditionally, animals have been looked to as prophets of weather change. Years of weather wisdom tell us cows and horses are restless, hens take shelter, frogs and toads come out of hiding, dogs become edgy as pressure drops and a storm approaches. As one saying puts it:

When a cow endeavors to scratch its ear,
It means a shower is very near.
When it thumps its ribs with angry tail,
Look out for thunder, lightning, hail.

Animals have been observed to hunt food actively and eat voraciously before a storm. Cattle and horses bunch together before a low pressure front; if grazing in a high area, cattle will move into sheltered valleys.

Many species of birds — robins, crows, gulls and geese — do not like to fly before a storm. The thinning air that accompanies a low pressure front is harder to fly in. In fact, the robin has quite a history of sticking close to its nest prior to a storm:

If the robin sings in the bush,
Then the weather will be coarse.
If the robin sings on the barn,
Then the weather will be warm.

Fish tend to be a more controversial weather predictor, with some people claiming they bite more frequently when the weather changes, while others claim the opposite. There is more general agreement on the behavior of fish when a major thunderstorm moves in: they are less active and refuse to bite.

"When the storm comes, the fish won't bite," says Kamenka. "They come up close to the surface, but then they go down a couple of hours before the storm. All the little flies hovering over the water surface disappear too."

Insects provide some of the best clues to weather change. In fact, you can determine the temperature by counting the chirps of a cricket, according to an Environment Canada publication. Simply count the number of chirps in an eight-second interval, add four, and the result is very close to the Celsius temperature. The hotter it is, the shorter the interval between chirps.

While nature has programmed storm sensitivity into animals, we humans have far duller instincts when it comes to weather. That doesn't mean they aren't there: many people testify to discomfort, aches and pain as low pressure and humidity presage bad weather. People who are prone to headaches, rheumatism or arthritis, or have bad teeth, improperly healed bones, stomach disorders, corns or bunions may report aches and pains prior to bad weather. Even our hair has been observed to become lifeless or hard to manage as the barometer drops.

"Many people are adamant that they experience changes in bodily feelings, but the results are very inconclusive that there is any predictability linked with the weather," says Keith Hage, professor of meteorology at the University of Alberta.

One study attempting to link migraine headaches to weather change was inconclusive, Hage says, "partly because the migraine headache itself is not very well understood."

Studies by botanists show that some plants react to atmospheric change, often by closing before a storm. Plants such as chickweed, tulips, African marigolds, clover and dandelions close when the relative humidity of the atmosphere increases to 80 per cent — often the point at which rain will fall.

Certain types of tree — oak, poplar, cottonwood — turn their leaves up as rain approaches, exposing their undersides.

Sky signs are probably the most dependable of all our accumulated weather wisdom. These signs can be very accurate on a short-term basis. Farmers who have lived most of their lives outdoors, says meteorologist Hage, "make excellent weather predictors."

For Hage, a useful weather observation is our best-known weather proverb:

Red sky at night, sailors' delight;
Red sky in the morning, sailors take warning.

While not totally failproof, this maxim is usually dependable as long as weather systems in your locality move from west to east as they do in Canada.

"I always encourage my students to watch for the sunset," says outdoorsman Kochanski. "That will give them a basic idea of the next day's weather. If the sunset is really red,

Clouds forming over Joy Kamenka's weather gauge — Three Sisters' Mountain near Canmore

the next day is usually quite nice."

Clouds are often an excellent visual display of complex weather patterns. The highest clouds are the cirrus, also known as "mare's tails" or "hen scratches." Travelling at great speeds, they are the first signs of a large, slow-moving warm front, often followed by an increase in wind and possible rain. Mare's tails have long been regarded as the earliest sign of a weather change:

Mare's tails, mare's tails,
Make lofty ships carry low sails.

The so-called "mackerel skies" of the next lower level of clouds can be recognized by their small, fluffy, white appearance. Again, they warn of the weather change accompanying a warm front's approach:

Mackerel clouds in sky,
Expect more wet than dry.

Before the warm front brings its promised rain, the next level of clouds must move in. Thus enters the dull, grey, leaden sky of the stratus clouds. As the front slowly moves in, these clouds hang very close to the earth's surface, bringing the drizzle of a warm front.

Perhaps our most common cloud is the fluffy, white cumulus cloud, appearing like puffs of cotton against a blue sky. When few in number and very white, they often portend bright, clear, pleasant weather:

If woolly fleeces spread the heavenly way,
Be sure no rain disturbs the summer's day.

These clouds also have the capacity to grow larger and taller, ushering in rain or a thunderstorm.

The violent prairie hailstorm also has its signs. "You can sense a real severe hailstorm by the bubbling, raspberry structure of the clouds," says Lub Wojtiw of the Alberta Research Council's Atmospheric Science Department.

Recognizing winds can be another useful cue to weather change. Prevailing west winds usually a sign of mild weather. Folklore tells us we should do our business when the west wind blows:

Wind in the west,
Weather at its best.

East winds are frequent harbingers of severe weather. Folklorists tell us the east wind is the lazy wind because "it doesn't blow around you, but it blows straight through you."

Albertans who live south of Claresholm and north of Waterton learn to recognize the dry west wind that blows out of the Rocky Mountains bringing a respite of balmy weather in the winter month. The chinook is accompanied by an arch that appears to stand still in the sky. A band of cloud forms east of the Rockies, and seems to bend at either end as it disappears over the horizon.

Sound takes on a different quality prior to a storm, and Kochanski often takes his cue from the sudden "clarity of sound and the ability to hear long distances before rain." Kamenka, too, knows that moment when one's hearing is acute, "when the lake is calm and still and you just know something's coming." It was thus this proverb was written:

Sound travelling far and wide,
A stormy day will betide.

Even the appearance of smoke blowing into the atmosphere can signal the advent of a storm. Since smoke is slightly lighter than air, a great deal of moisture will cause the smoke particles to become moisture-laden, sending the smoke on a downward plunge from a chimney.

One important warning for those wishing to delve into the art of observation forecasting. Much of the lore is patently untrue, having been changed through generations of retelling, or worse, transplanted into a locale where it has no merit.

"My American mother-in-law has a saying that the corn must be knee-high by the fourth of July," says Lub Wojtiw. "I told her good luck, with growing seasons in this part of the world."

Other proverbs may be rooted in superstition or fear. "People says certain types of tree, like the beech, are immune from lightning," says Keith Hage. "That's quite incorrect, and it's proven so by examining the bark and structure of the tree."

Perhaps the best strategy is to apply the various bits of wisdom to your locality, and hang onto the ones that seem to work. Used together with modern forecasting, they can introduce you to the complex field of observation forecasting, and perhaps open your eyes to the subtle changes taking place in the world around you.

One last bit of advice though. Never forget that sage piece of wisdom from prairie farmers:

"All signs fail in times of drought."

Helen Corbett is a former journalist who now lives in Canmore and works as a film-maker and freelance writer

Sharon Adams

Change and Variability

Are we due for another Ice Age?

Perhaps the best way to visualize the effects of change and variability in weather and climate is to look at the whole question as if it were a giant card game. The high cards are solar radiation, its reflection, its absorption by atmosphere, earth and sea; and the geographic location of points on the earth. Add cards for geographic detail (proximity to mountains and large lakes, for example), prevailing wind, proximity to pole or equator, evapotranspiration, seasonal variations, temperature ranges and precipitation. Then throw in some wild cards: sunspot activity, volcanic dust veils, accumulation of carbon dioxide in the atmosphere, and the joker — the effect of man's activities.

The climate and weather, how they change, and how they vary in any one place is determined by the cards dealt. Though long-term changes of climate and weather have been documented, variability can occur due to the "wild cards." This prevents meteorologists from betting on the deal for next season's weather, and keeps climatologists cautious in predicting variability in climate.

Fossil evidence shows that at one time Alberta's climate was much warmer; geological evidence proves at other times it was much cooler. Alberta has at various times been covered by glacier, tropical vegetation, fresh-water lake, and ocean — at various times the Arctic, Pacific, Atlantic — even the Gulf of Mexico.

These long-term and gradual changes are evidence of evolution in climate which could have been caused by any number of factors. Though the earth has had a mostly warm history, seven times great glaciers, interrupted by warm spells of about 10,000 years, have advanced. Although it has been just about 10,000 years since the last glacier retreated, there's no reason for Albertans to pack for a move to sunnier climes, come the next hard winter. Instead, they should take heart in the fact that while temperature patterns appear to be similar to those of the last 10,000-year warm cycle, it is thought the pattern of solar radiation and absorption and geological activity is different. Maybe the next Ice Age will be tardy; maybe the last one was the last of its kind.

Michael Hic[illegible]

Or, as Mal Berry, chief of applications and impact division of Environment Canada's Atmospheric Environment Service in Downsview, Ont., says: "Nobody knows for sure."

Changes in global climate are believed to be affected by such diverse factors as the solar system's movement through the galaxy (fewer of the sun's rays reach earth when the system is travelling through "thicker" space); fluctuations in the earth's orbit; changes in the earth's axis of rotation (which can cause a shift in the poles, such as happened 50,000 to 17,000 years ago when the north pole was located in what is now Hudson's Bay); continental drift (movement of the continents in relation to the poles, equator and each other — which accounts for Alberta's tropical climate when it was much further south); and great geological events such as mountain-building (reputedly responsible in part for the onset of the ice ages as volcanic dust blocked sunlight and oceans, which "store" solar heat, were disturbed).

Variability in climate has been variously attributed to: sunspot activity (believed to have been largely responsible for Alberta's modern droughts); the presence of carbon dioxide (which has accumulated naturally in the past and is now accumulating again thanks to use of the internal combustion engine and harvest of forests); volcanic activity (which kicks up dust, increasing the amount of solar radiation reflected before it gets a chance to hit the earth, thus lowering temperatures); cloudiness or fogginess (which can have the same effect as reflection) and man's activities (such as poor farming and water husbandry practices which exacerbated the effects of the Dirty

Volcanic activity (Mt. Saint Helens left) blocks solar radiation by forming a layer of dust

Lake core sample. Different sediment layers.

Dinosaurs once roamed in the tropical vegetation over most of Alberta.

Thirties drought in western Canada and the U.S.).

The past climate of Alberta has been recorded for us in the sediment laid down in ancient lake bottoms. Scientists such as Dr. Michael Hickman of the University of Alberta botany department examine cores taken from such lakes, made up of layers of organic and inorganic sediment. In conjunction with radiocarbon dating information, the cores offer a picture of the regional and local climate that existed at the time of deposition. Differences in the type and abundance of the particles which make up these sediments reflect the prevailing climatic conditions. For example, the presence of large amounts of pollen from certain saline-tolerant acquatic plants indicates alkaline water conditions, caused by hot dry weather when lake levels would have been dropping rapidly.

Since the retreat of the last glacier, man has come to dominate the earth. Between 7,000 and 3,500 years ago, the time encompassing the great Egyptian empire, North America became quite warm. Core samples from Alberta lakes show a gradual change to a warmer climate documented by pollen samples showing tundra growth being gradually replaced until modern vegetation appears. The lake core samples also show Alberta has been subject to many droughts.

The North American climate cooled between 1,000 B.C. and 400 A.D., the period spanning the Greek and Roman empires. A 400-year span of warmer weather began in 800 A.D., during which time the Norse settled on Greenland and the Inuit migrated northwards. From the 17th to the latter 19th centuries the Little Ice Age occurred. The Norse colonies died out and the Inuit migrated south again. One of the "wild cards" was dealt in 1816: the eruption of Tambora in Indonesia threw up a dust cover which blocked the sun's rays for a period of years, producing a year without summer which resulted in widespread starvation of settlers in the U.S. and what was to become Canada.

Shortly afterwards, records began to be kept on the prairies which document broad climatic changes — general warming and cooling trends — and variability — rain, snow, wind and drought. The records show a warming effect after the end of the Little Ice Age, and the advent of a cooling trend in the 1940s which scientists predict may last between 30 and 60 years. Records also document lower temperatures here following the eruption of Krakatoa in 1883; the very wet, and consequently bountiful, period between 1902 and 1906; the droughts of 1910 and 1919, which have been related to increased sunspot activity; and the 1967 and 1980 droughts, which contributed to fierce forest fires the following summers.

Susan Hunt

DR. MICHAEL HICKMAN

These records, along with other evidence of change and variability in climate and weather show the importance of planning, to mitigate effects of short-term variability and to cope with long-term climatic change. This, of course, heightens interest in prediction of both.

Bruce Thompson, scientific services meteorologist with Environment Canada's Atmospheric Environment Service in Edmonton, says "variability . . . causes the biggest problem." Meteorologists can supply forecasts which can be immediately useful, and the fluctuations they record can be an indication of range of severity in weather which must be accommodated in planning safety margins.

Forecasts, he says, can help the construction industry plan sensitive work around bad weather, like extremely cold periods. Farmers use the information in sowing and harvesting — and such chores as applying herbicide and pesticide that may drift with the wind. A record of low temperatures indicates how much insulation or energy is needed to keep interior spaces habitable during cold snaps.

Weather variability affects farming so much, in fact, that Alberta Agriculture has agrometeorologists to provide information and advice on effects of variability on agriculture. The branch also does research to overcome some of the climate-imposed barriers — such as the short frost-free growing period which can be overcome by development of cold-resistant strains of wheat and, as lately researched, control of the bacteria which cause breakdown of plant fibres after

The years between 1902 and 1906 brought wet weather and bountiful harvests to the prairies.

Provincial Archives of Alberta

frosts.

This advanced technology, combined with a benign climate in the '50s and '60s, turned the high plains harvests into bumper crops.

Drought is a special weather enemy which is fought by the Prairie Farm Rehabilitation Administration in Regina, which helps farmers plan in a safety margin in their operations. Even two low-yield seasons can spell disaster for an individual farmer, even if those seasons are followed by wet years producing bumper crops. The PFRA's deffensive measures include research on experimental farms, community pasture programs, water development (farm dugouts and irrigation reservoirs), and tree planting programs. Offensive strategy includes transfer of water from one river system to another in times of emergency.

But *variability* of weather and climate is short-term. As indicated by Calgarians' favorite saying about variability: "If you don't like the weather here, wait a minute," it is necessary only to wait for conditions to improve. But a long-term, gradual, and irreversible *change* in climate can be much more disastrous.

The late Professor Richard Longley, an eminent Alberta weather and climate researcher, wrote in 1977 that while "the last 50 years give us our best guide to what we may expect in coming years . . . the area and the world are vulnerable to events, such as volcanoes, that affect the weather and cannot be predicted. Some of these could make farming on the prairies . . . impossible for a number of years, or for centuries, if we should enter into another Little Ice Age."

Lake core samples show Alberta has had periods of drought lasting thousands of years.

But it has been noted that while climatic variability can spell the difference between life and death in some parts of the world, the impact on Alberta has been, and is likely to continue to be, economic. And because Alberta lies at the northern limit of arable agriculture, that business is the most likely to be seriously affected.

Depending on which expert is speaking, Alberta is to have one of two climatic futures: either it will be warmer than it is now, or it will be colder. Either scenario would result in tremendous changes.

A warming trend, for example, could result in both benefits and problems. While the temperature range for agriculture would be increased, gains made in pushing agriculture the small distance northward to the limits of usable soil would be offset by the probable loss, through high temperature and lack of moisture, of the south and southeastern areas which are now productive.

Few economic segments would be unaffected. Fisheries sensitive to change in heat and run-off, could suffer; forestry, initially benefitting from higher temperatures further north, would have to contend with temperature-related infestations of insects: the medical industry would have to contend with diseases virtually unknown now in the temperate zone: transportation engineers would have to contend with muskeg and bog where permafrost once prevailed.

A cooling trend could have an even greater impact. Again, because Alberta's agriculture lies on the fringe of arable land and temperature, a decrease of just 1.2 degrees Celsius would reduce the frost-free period by about 10 days. Wheat needs a 100-day growing season. This would have implications on the research and development sector of almost every industry, which would have to cope with overall lower temperatures that while not making life impossible here, would make it more difficult.

In addition, either trend could have spin-off effects which cannot be calculated. Precipitation patterns might be altered; wind speed may change, causing problems in spreading herbicides, pesticides and seed; seasons may change more rapidly, with melt-off and winter freeze occurring over very brief periods; water resources, already under pressure from competing users, could become more strained; the range of extreme temperatures may widen, a factor that must be kept in mind when designing tools, equipment, machines, clothing, housing, sewage systems and utility delivery systems.

But this does not mean that either possibility spells disaster for human habitation of the province. Indeed, Dr. J. Maybank argued at the Climate Change Seminar in Regina in 1981: "(technological changes) should be chosen with care so efforts aren't wasted on unlikely-to-be-needed modifications." Through careful planning and engineering, he said, "we can be in a position to mitigate various climate effects of both type and magnitude, regardless of their direction."

Sharon Adams is a Calgary journalism instructor and freelance writer.

Gillian Sniatynski

Severe Weather

Learning to cope with sudden storms and howling winds.

A summer deluge in 1977 washed out a bridge and several houses in Edmonton's Mill Creek Ravine

To visitors from more temperate climates, a bitter Alberta winter — in fact, *any* Alberta winter — is an operational definition of severe weather.

Natives are hardier, of course. But even they were impressed by a winter like that of 1969, when for 26 days in January and early February the temperature in Edmonton was below zero Fahrenheit. (The local newspaper published special certificates for survivors!)

More dramatic was the Great Prairie Blizzard of December 14 to 16, 1964. It combined very low temperatures (at its worst -32 deg. C. in Edmonton, -34 in Red Deer, -35 in Coronation, for example) and very high winds (60 kph in Red Deer, 55 kph in Calgary.) The conditions yielded a wind chill of almost unimaginable viciousness.

The small amount of snowfall during the blizzard didn't close the highways, however, and there was plenty of advance warning, so no human lives were lost through direct exposure. But three people froze to death when their stoves went out during the night. And there were extensive losses in livestock and wildlife. Some ranchers reported the loss of half their herds — about 1000 head died in southern Alberta during the storm and the four-week cold spell which followed. Wildlife officials estimated that 50 to 70 per cent of southern Alberta's pheasant population perished.

The blizzard developed along classic lines, meteorologically speaking. To the west of a rapidly deepening centre of low pressure, cold air was moved southwards by strong winds, accompanied by light snow and blowing snow.

Nasty as they are, blizzards are generally not too difficult to forecast. And blizzards aside, *all* of us can forecast the general run of winter weather, because it's the product of fairly stable weather patterns.

Winter weather lasts for a long time and covers a lot of territory. It's inconvenient and often uncomfortable. But only the foolhardy are likely to endanger their lives in it, and property damage is minimal.

Of much greater concern to meteorologists are the sorts of severe summer weather occasionally visited on us.

"When we talk about severe weather, its local nature comes into play — it's the variability in weather on a small time and space scale," says Dr. Brian Barge, head and program manager of the atmospheric sciences department of the Alberta Research Council.

Thunderstorms, hail storms and tornadoes differ from the winter phenomena in that they last only a short while and are usually highly local. And they occur during the growing season, when damage can be devastating.

A report from the Alberta Weather Centre on summer severe weather in 1982 notes that the Alberta Hail and Crop Insurance Board expects to pay $40 million for hail damage caused last summer, compared to $20 million in 1981. Most of the 1982 hail damage was done by a few storms — notably one on July 21, the heaviest recorded since 1971. That storm started west of Rocky Mountain House about mid-afternoon and travelled east through Bashaw before ending south of Lloydminster by midnight. The storm track was estimated to be 230 kilometres long and 60 kilometres wide. It covered some 1.2 million hectares with hail ranging in size from grapes to golf balls (or worse).

Last summer there were also 26 tornadoes reported — possibly a record for Alberta. Our tornadoes usually last only for 10 minutes or less, and are smaller in scale than their U.S. counterparts, but they are a substantial threat even so. At Dovercourt, southwest of Rocky Mountain house, one person was injured and damage estimated at $500,000 was caused by a tornado on June 30. On the same day a tornado near Kinsella moved a steel bin 800 metres and overturned a three-ton truck. There was also considerable crop damage.

Summer severe weather is the product of convection currents. Air in contact with the sun-warmed ground rises, cooling as it does so until condensation occurs. Condensation releases heat, the moist air continues to rise and gets colder.

A tornado (left) in the Rocky Mountain House area caused $500,000 in damages.

Vic Maxwel

A large part of the professional concern stems from the fact that this process happens so rapidly, so locally and is consequently so difficult to forecast.

It follows that improved forecasting of summer severe weather is an important research thrust.

"In general our long-range forecasts are not bad," says Dr. Barge. "But in summer it's very hard to say that the Edmonton region will be lashed by certain storms of certain severity. We need to use special techniques to take into account the local nature of the storms."

Meterorologists at Environment Canada's Alberta Weather Centre and the Alberta Research Council are experimenting with the use of satellite data, combined with weather radar, to get more information about local atmospheric conditions. Weather radar alone is accurate, but each station typically can only "read" to a radial distance of 250 kilometres — and stations are few and far between. On the other hand, satellites provide much less specific information, but over a much broader territory.

Dr. Barge says preliminary tests of the new procedures in the forecasting of hail are encouraging.

"If you are interested in, say, whether it is going to hail in central Alberta, we can tell you with 80 per cent accuracy," he said.

Weather modification takes forecasting one step further. For example, the Alberta Research Council is working with Alberta Agriculture on research aimed at the suppression of hail. Dr. Barge points out that the concept of cloud seeding has been around since the 1940s. Now, however, the emphasis is on finding out more (by the use of weather radar and research aircraft) about the internal structure of thunderstorms, in order to test the effectiveness of cloud seeding.

Before weather modification becomes a fact of modern life, however, improved forecasting will ensure that severe weather doesn't catch us unawares.

The Alberta Weather Centre has a system of weather warning bulletins intended to alert people to hazardous weather conditions. The bulletins are issued whenever actual or expected conditions may endanger lives, property and the "welfare of the general public."

Weather *advisories* are issued when actual or expected weather conditions are less than hazardous, but still likely to cause inconvenience or concern. They may also be used to alert the public when there is insufficient information to justify a warning. Advisories are issued for such conditions as freezing drizzle, heavy drifting or blowing snow, thick fog, thunderstorms or severe wind chill. Many are directed to travellers.

Gillian Sniatynski is an Edmonton freelance writer and the former editor of *Environment Views*

Alberta Weather Centre Weather Warnings

Type	Criteria and description
Blizzard warning	Visibility less than 1 km with snow and blowing snow; wind greater than 40 kph and temperature less than 0 deg. C., with the conditions lasting three hours or more.
Dust storm warning	Visibility less than 1 km; wind speed greater than 40 kph with the conditions lasting more than six hours.
Frost warning	Temperature expected to fall below 0 deg. C. during the growing season (as defined locally).
Heavy snowfall warning or snow warning	10 cm (or more) accumulation of snow or wet snow expected to fall in 24 hours.
Heavy rain warning	Rainfall of 50 mm or more expected in 24 hours. (Rainfall criteria may vary from season to season).
Freezing rain warning	One hour or more of freezing rain expected.
Wind warning	Wind speed expected to be 60 kph or more, and/or wind gusts of 100 kph (except Lethbridge region, 70 and 120 kph).
Severe thunderstorm warning	Extremely strong winds, hail or lightning associated with a severe thunderstorm expected.
Tornado warning	[On rare occasions, a warning may be issued for the expected occurrence of a tornado. This would normally be delivered as a severe thunderstorm warning, with a risk of tornado. But the present warning system (media) would be unlikely to be able to handle an actual occurrence because of the short life of Alberta tornadoes.]

Wind Chill Factor

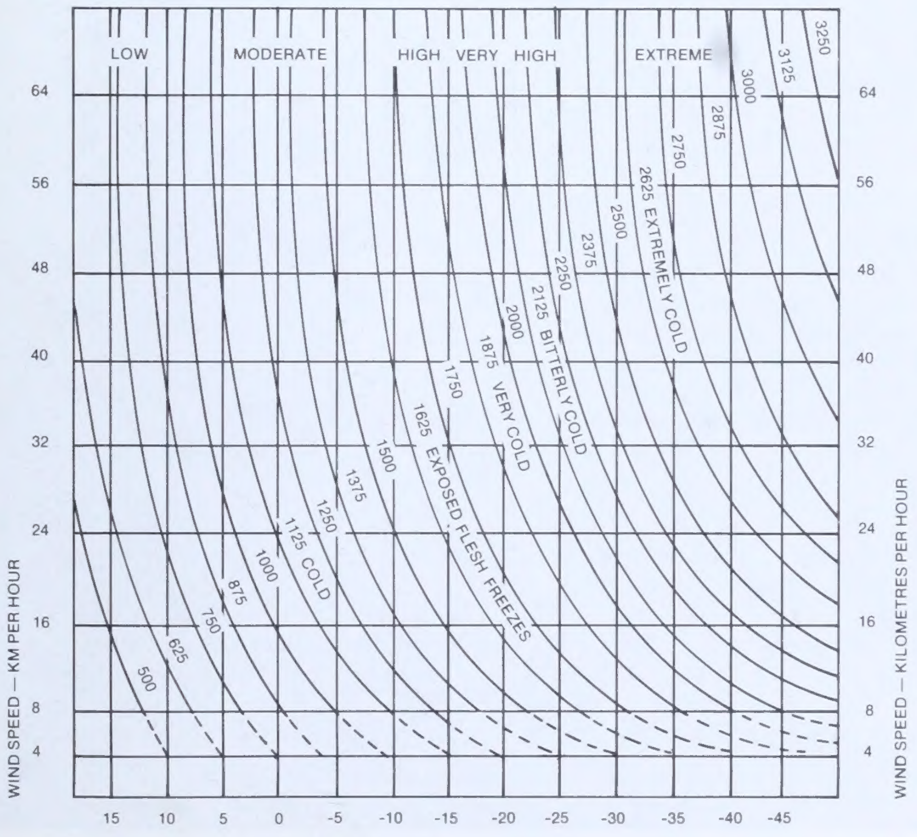
Nearly everyone is aware of how much colder it feels outdoors on a windy day as compared to when there is no wind, particularly in the winter. This apparent 'coldness' is due to the more rapid cooling effect produced by the wind to make it feel colder than it really is. The combined effect of wind and low temperatures is experienced by most Canadians in just about every part of Canada. The effect can produce serious and often dangerous conditions.

Wind chill factor is a measure of the combined chilling effect of wind and temperature. Although the actual calculation of the factor is based upon how fast water will cool with the combination of low temperature and wind, it has been found to be equally applicable to the cooling effect experienced by the human body and by an inanimate object.

The advantage of wind chill factor over other measurement methods is that it represents a real rate of cooling, in other words how fast an object cools. For example, the combination of a specific temperature and wind speed can be related to how fast exposed flesh will freeze. On the average the value of 1625 watts per square meter represents the condition where exposed flesh will freeze. It also gives an indication of how difficult it is to maintain an object, for example a house, at a given temperature.

In the past it has been common practice to use an equivalent temperature (wind chill temperature) to relate wind and temperature. Unfortunately the values obtained by this method often have been beyond the experience of most people. For example, -50° C occurs in relatively unpopulated areas of Canada. More importantly the equivalent temperature still does not relate to the combined effect of wind and temperature on the human body. It also is too easily confused with the actual temperature.

WIND CHILL COOLING RATES
(Watts Per Square Meter)



To determine the *wind chill factor* follow the temperature across and the wind speed up until the two lines intersect. The value of the wind chill factor can be interpolated using the labeled wind chill factor curves.

Air Temperature — Degrees Celsius

For example, at -10° C with a wind speed of 32 kilometres per hour the point of intersection lies between 1500 and 1625, or approximately 1570.

It is not recommended that wind chill factors be calculated for wind speeds below eight kilometres an hour, since it is difficult to determine wind chill factors at these wind speeds and because other factors such as relative humidity become important.

The Effect of Wind Chill

1. Water will freeze more quickly at high wind chill factors than at low.

2. The ability of an engine block heater to keep a car engine warm decreases with increasing wind chill factor.

3. The length of time a car can be left turned off before reaching the surrounding air temperature decreases with increasing wind chill factor.

4. With increasing wind chill factor there is an increase in the fuel needed to heat buildings, particularly when the building is poorly insulated.

5. Exposed flesh freezes more rapidly with higher wind chill factors.

Examples of Wind Chill Factor

Wind Chill Factor	*Comments*
700	Conditions considered comfortable when dressed for skiing.
1200	Conditions no longer pleasant for outdoor activities on overcast days.
1400	Conditions no longer pleasant for outdoor activities on sunny days.
1600	Freezing of exposed skin begins for most people depending on the degree of activity and the amount of sunshine.
2300	Conditions for outdoor travel such as walking become dangerous. Exposed areas of the face freeze in less than one minute for the average person.
2700	Exposed flesh will freeze within half a minute for the average person.

Units of wind chill factor are watts per square meter.

Measuring Rainfall

A simple instrument for collecting and measuring rainfall is called a rain gauge. Here is a way of making such an instrument yourself.

You'll need

1. Tin can, open at top, with no lip, so you can pour rain out of it easily.
2. Wood to make a little platform (a log or a box stuck into the ground on end will also do).
3. Ruler
4. Tall glass jar (a very narrow one with straight sides like an olive jar, chili sauce bottle, Alka-seltzer bottle, etc.)

To make it

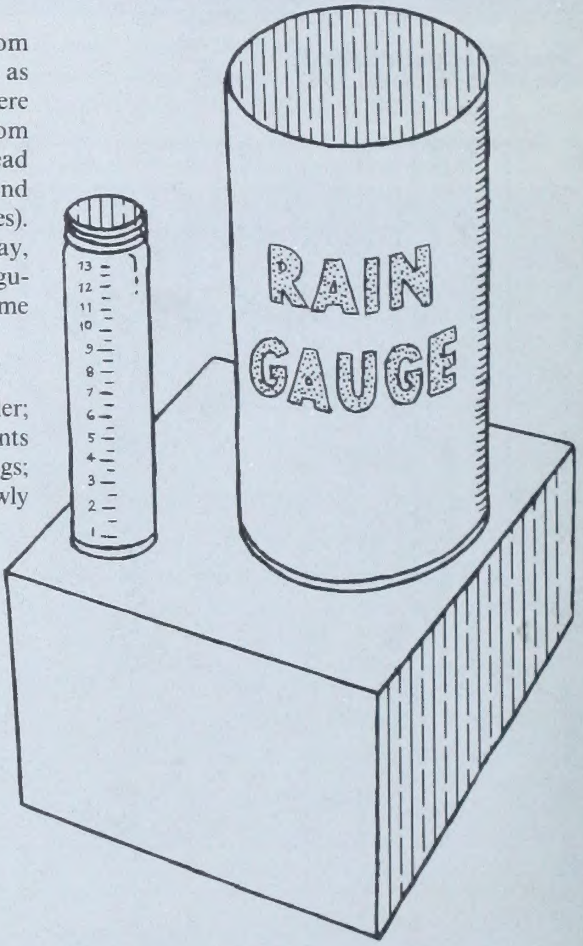
1. Make stand of wood, log, box, etc., to hold tin on top so it won't fall off. The open top of can should be level and about 30 centimetres above the ground.
2. To calibrate jar: pour one centimetre of water into tin can. Pour this water into tall jar and mark water level with grease pencil or paint. This will be the mark for one centimetre of rain. From this first mark you can measure and mark up tenths of centimetres all the way to the top of the jar.

To use it

Put rain can as far away from buildings, trees, fences, etc., as possible so they won't interfere with rain catch. Pour rain from can into calibrated jar and read off rainfall in centimetres and tenths of centimetres (millimetres). Read rain can at least once a day, or better still, twice a day, at regular times, say at breakfast time and at suppertime.

NOTE

To measure snow, just use a ruler; stick it into snow at several points in the year; average the readings; distinguish between old and newly fallen snow. Ten centimetres of snow equal one centimetre of rain.



Using Environment Views in the Classroom

The topic of weather and climate is one which all students do discuss. The problem becomes not how to initiate a discussion on weather but how to channel that discussion into the curriculum of either Social Studies or Science in a meaningful way. We hope this issue and the next one of Environment Views will provide teachers with the information to incorporate weather and climate into their program.

This issue of Environment Views concentrates on the technical side of climate and weather (as well as some interesting folklore) and therefore has a greater interest in the Science curriculum . The next Environment Views will deal with the human side of climate and weather and will present topics of more interest to Social Studies teachers. However both issues of Environment Views have some aspects relating to both.

Relationship to Curriculum

Social Studies

Two distinct topics arise from this issue on weather and climate that could be of interest at the grade 9 and 11 levels.

Social Studies 9, Topic C, Industrialization in Canada

This issue of Environment Views points out that modern technology has improved weather forecasting from 50 per cent accuracy (as for folklore) to 85 per cent. Improving the accuracy of weather forecasts about 85 per cent may require a substantial increase in the amount of funds. Grade 9 students could look at a number of issues dealing with that topic.

Should additional funds be available to increase the accuracy of weather forecasts?

Of what industrial value would this be?

At what level would weather forecasting be considered accurate?

Social Studies 20, Topic B, Global Problems of Population and Resource Distribution

A topic which may be introduced with this issue and then expanded with the following issue of Environment Views concerns the effects of changes in climatic conditions would have on the world. A number of issues arise from the possibility of the average temperature in the world increasing or decreasing by 1°C.

(a) food supply?
(b) population growth?
(c) resources development?
(e) economic power?

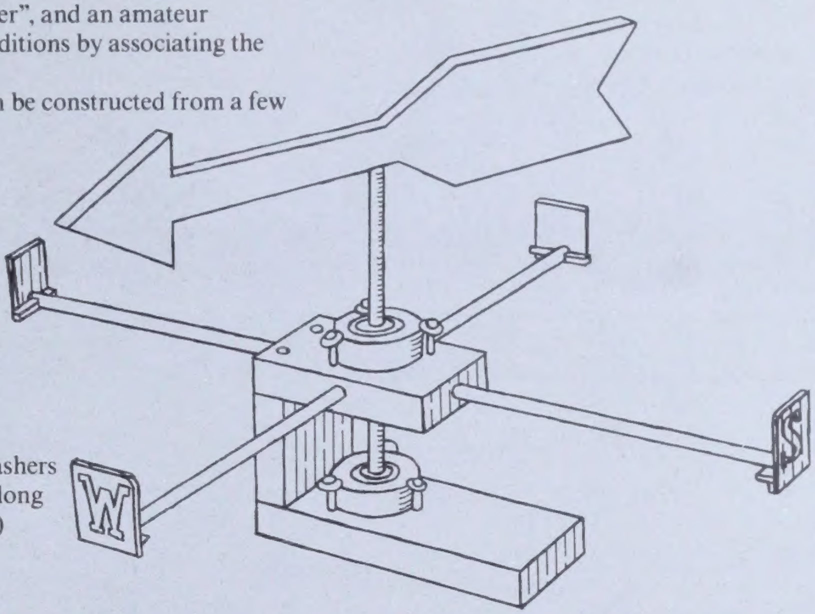
Science

Weather and climate could be an interesting topic of study in many areas of the Science

Determining the Wind Direction

It's a basic weather rule that "the winds bring the weather", and an amateur weatherman can become adept at foretelling future conditions by associating the wind direction with other weather signs.

A simple wind direction instrument as illustrated can be constructed from a few basic materials.



You'll need
4 pieces of wood about 19 mm thick and of the following approximate dimensions:

- 10 x 18 cm (for bottom of base)
- 10 x 10 cm (for top of base)
- 10 x 8 cm (for upright part of base)
- 40 x 8 cm (for arrow)
- 2 roller skate wheels
- 6 large-headed screws about 2.5 x 5 cm long, with washers
- 5 dowels (round sticks) about 6 mm diameter 20 cm long
- 4 pieces of metal about 5 x 5 cm (for direction letters)
- glue

Making the Instrument

1. Cut out arrow from largest piece of wood. The tail of the arrow should be made much larger than the head to obtain best results. It's a help to draw half the arrow along the fold of a piece of folded paper, then cut around the outline. When the paper is opened flat it will provide a pattern with uniform shape for both halves.
2. Find the point of balance of the arrow, drill a hole at this point and glue one dowel into the hole.
3. Drill ½″ (1.3 cm) hole through top of base and half way through bottom of base.
4. Fasten skate wheels over each hole with 3 large-headed screws.
5. Force dowel attached to arrow through holes of wheels so that the bottom of the dowel doesn't quite touch the wood base. Wax the end of the dowel so that it won't bind as it turns.
6. Glue remaining dowels into holes drilled around top of base. Paint letters on each of metal squares (N, E, W, S) and tack these directional letters to the ends of the dowels.

Mounting the Instrument
Erect the instrument in a location free from wind obstructions and well off the ground. If possible, line up the N marker with the North Star in order to properly position the directional letters. A pocket compass may also be used to determine the positioning but the readings will be magnetic rather than true bearings.

Using the Instrument
You'll notice that the arrow will point into the wind and therefore will indicate the direction *from which* the wind is blowing.

The arrow will vary in position from minute to minute especially if it is located where there are gusts and eddies caused by surrounding obstructions.

You may be surprised to find that cloud, rain and snow do not always come from the direction from which the surface wind is blowing. However, experience will teach you what wind directions in your locality are most likely to bring fair weather, rain or snow.

curriculum. At the Junior High level it could provide an interesting unit of study. In high school it provides an interesting topic for study in some parts of the Biology and Chemistry curriculum.

Biology 20, Unit II, Environmental Biology
Biology 30, Unit II, Current Biological Problems

Topics which would be studied include:

(a) How can man manipulate the weather? (in conjunction with the next Environment Views issue)?
(b) What effects do climatic changes have on plant and animal life?
(c) Can plants and animals detect climatic changes? How do they adapt to these changes?

Finally, individual student projects in Biology or locally developed teaching units on weather and climate for Science II could use all of the articles in this issue of Environment Views for detailed information on weather, measuring climate and weather, changes in global climates, variability of climatic conditions (as well as their effects on Alberta) and the effects of severe weather changes.

If undelivered, return to:

Environment Views
Alberta Environment
9820 - 106 Street
Edmonton, Alberta T5K 2J6

Environment Update

Agriculture and the Environment

Proceedings of the Agriculture and the Environment Symposium sponsored by the Canadian Society of Environmental Biologists — Alberta Chapter, are now available.

The proceedings contain papers presented at the symposium, March 6, 1982. The papers, by representatives of industry, government and public interest groups address a wide range of interactions between agricultural activities and the natural environment. Issues discussed include; land reclamation, effect of sulphur deposition on livestock, conflicts between agricultural development and wildlife, preservation of agricultural land and the potential impact of water management schemes.

The Proceedings are available at a charge of $10 from

Canadian Society of Environmental Biologists — Alberta Chapter
P.O. Box 12, Substation 11
University of Alberta, Edmonton
Alberta, T6G 2E0

Environmental Biologists Meet

The Canadian Society of Environmental Biologists is a national organization of people educated and working in the biological sciences. Its objectives are to evaluate, and advise the government on, those policies and actions which have environmental implications. The society is also interested in maintaining high professional standards in natural resource education, research and management.

Monthly meetings are held in Edmonton and Calgary, during which feature speakers address resource management and environmental issues. Meetings in Edmonton will be held at the Lecture Room, Provincial Museum of Alberta, Jan. 10, Feb. 14, March 14 and April 11. For further information call **John Lilley** (427-5792, Edmonton), Lewis Cocks (420-2600, Edmonton), or Mark Polet (233-3976, Calgary).

Bill McKeown

Prairie Water Symposium

The Environmental Resource Centre is co-ordinating a symposium on prairie water resources, to be held in Edmonton in late February (exact date and location were unavailable at press time). Topics to be discussed include:

- Slave River Dam proposal
- Garrison diversion project
- Interbasin water transfer
- Water quality
- Heritage Rivers Program
- Native advocacy and treaty rights

For dates, location and other information, call the Environmental Resource Centre 424-3301.

Environmental Law Course

The Environmental Law Centre and the John Jantzen Nature Centre are co-sponsoring a five-part evening program at the nature centre entitled **Environmental Law: Making It Work For You**, beginning February 2.

The course will provide participants with an overview of environmental legal actions and remedies in the context of Alberta case histories. Topics to be discussed include: the law related to pollution control; pesticide use; water diversion and dams; and hazardous wastes.

The final session will outline how planning law and policy effect change and how they can be directed to preventive and protective purposes. Participants will be encouraged to share their experience and viewpoints.

For further information, call the Environmental Law Centre 425-6740.

If you have a short news item of province-wide interest you'd like to contribute to Environment Update, please send it to the editor at the address on the Contents page. The editor reserves the right to select and edit the items.